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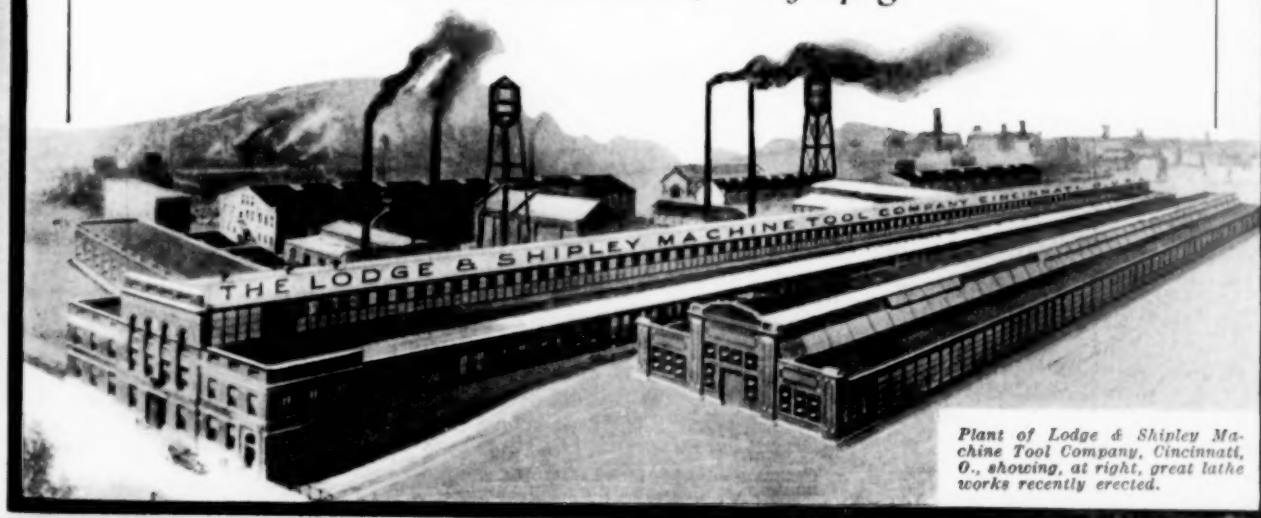
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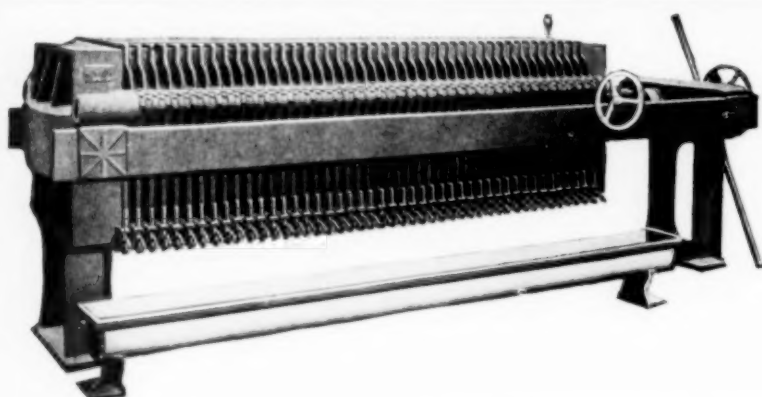
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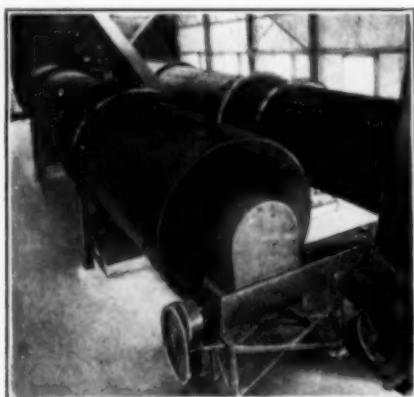
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A Chance To Try Again

THE Army appropriation bill, including among other things money for the Chemical Warfare Service, failed of enactment because it was pocket-vetoed by the President at the close of the last Congress. In many respects this is an unfortunate thing, as it leaves the new Congress with one added burden—namely, the provision for routine affairs of the Army for the next fiscal year. However, the cloud has a silver lining which is not hard to see, for it gives all of us another opportunity to boost the cause of chemical warfare again and with some hope that more adequate provision will be made for this branch of the Army.

Chemical industry is in many ways intensely interested in chemical warfare. A new aspect of this interest has recently become more conspicuous than ever before in the numerous claims against the Government for the after-effects alleged by those who have been gassed. There are nearly a million claims against the Government now pending in the War Risk Insurance offices. Nearly a quarter of these allege serious after-effects from gas. The intangible nature and the rather novel symptoms involved make it particularly difficult to settle these claims generously yet justly. The importance of this to chemical industry is obvious, for if the Government begins making adjustments for effects of gas every industrial establishment handling chlorine, phosgene, chlorpicrin and other toxic commodities of modern organic chemical activity will be confronted by unfounded claims for damage especially in states where industrial commissions look after workmen's compensation legislation. Chemical industries will, of course, not wish to dodge any right and proper responsibility in these matters, but at the same time it cannot safeguard itself too carefully against precedent that may be established by unreasonable generosity of the Government. One way to do this is to insure proper funds for study of these problems by C. W. S.

On many scores chemical industry and professional men generally will want to see all of the research and development work of chemical warfare properly advanced during the coming year. The only way to insure this is to see that Chemical Warfare Service gets the needed appropriations. That service originally asked for only about 2 per cent of the total sum which Congress proposes to grant for Army maintenance and operation. Yet this service is vital to every branch of the Army and without co-operation of this service every other branch is potentially useless against an enemy well prepared for chemical warfare. It is none too soon for all of us to emphasize these points to our representatives in Congress. In redrafting the Army bill for the new Congress at least double the amount

provided by the bill passed in the last Congress is essential. C. W. S. asked for eight and one-half million dollars. The Secretary of War cut this to four and one-half million before submitting the estimates to Congress, and Congress pared still further to one and one-half million. On this last basis the service can barely keep from slipping backward in mechanical plant and can do but a fraction of the needed research. It can make practically no masks at all. This would be a shameful condition. With \$3,000,000 the engineering facilities of the service can be maintained, a small amount of research and development work can be continued with a skeleton organization and a reserve supply of masks of each of the newer types needed can be made to replace obsolete forms now in hand. Surely that is the least which we can demand of the service during the coming year.

Research Opportunities of the South

DR. RAYMOND F. BACON, Director of the Mellon Institute of Industrial Research of the University of Pittsburgh, delivered a convincingly forceful address on "The Strengthening of Industries by Research and Experimental Engineering Work" at Macon, Ga., on March 15, before the leading representatives of Georgia's industries, at a meeting called to establish an industrial experiment station to be connected with the Georgia School of Technology of Atlanta. The convention was the sequel to the trip of inspection made last November by a party of Georgian manufacturers, accompanied by Governor DORSEY and Dr. K. G. MATHESON, president of Georgia Tech, who visited the important industrial centers of the North, and, while in Pittsburgh, familiarized themselves with the system of industrial research in successful operation at the Mellon Institute. It is reported that the Macon meeting was the largest gathering of industrial leaders ever held in the South, and it is understood that plans have been formulated to interest all lines of manufacturing in the project and to raise funds for the proposed industrial research establishment at Atlanta, to serve Georgia and that section of the South. The chambers of commerce and other civic organizations throughout the state are enthused and have indorsed the idea without exception, and the supporters of the plan have reason to believe that there soon will be a "Mellon Institute" in the Gate City of the South.

Dr. BACON's discourse was impressive in indicating the accomplishments of properly planned, systematically executed industrial research. He related the rôle played by scientific investigation in the development of the petroleum, cotton oil, sulphur, hydrometallurgical, and iron and steel industries; and he pointed to naphtho-py-
rolysis, hydrogenation and flotation as three of the

greatest results of industrial research. It was brought out by Dr. BACON that approximately \$25,000,000 is being spent annually by our industrialists in the conduct of laboratory chemical research, that probably an equivalent sum is being expended for unit experimental plant and factory investigational work, that several of our largest corporations are investing as much money in research as they are laying out for advertising, and that about \$50,000,000 is being saved each year through the application to manufacturing of the findings of scientific inquiry. The sum of \$400,000 was spent last year in carrying on industrial research at the Mellon Institute, where there are now forty-eight distinct technochemical subjects under study and eighty-three expert research chemists at work thereon.

Dr. BACON made particular reference to the opportunities which exist in the South, and especially in Georgia, for using research in the upbuilding of industry, especially in connection with wood products, textiles and vegetable oils. The field of problems invites investigational exploration, and the Georgia School of Technology provides the port of embarkation for the expedition.

The Chemistry Of Olfactics

A CORRESPONDENT of the London *Daily Mail* lately contributed a note on some curiosities of smelling. He found three or four hens pecking over a rubbish heap on which some calcium carbide had lately been thrown, and while the place reeked of acetylene the hens did not seem to mind it. He observes that the sense of smell of birds is generally slight, that their olfactory bulbs are very small, and that in some, such as the frigate bird, the nostrils are obliterated. On the other hand, regarding man, he declares that the half-savage Ainu of north Japan can track game like a dog, by the nose alone. JAMES MITCHELL, the English blind deaf-mute, recognized his friends when they came into a room, simply by their smell. Dean BUCKLAND, the geologist, when riding once with some friends and the party lost their way and were overtaken by night, alighted from his horse, picked up a handful of earth, smelled it, and at once declared they were near Uxbridge. He knew the geology of the land and the smell of the soil.

Of dogs the *Mail* correspondent says that the opinion prevails that they are better able to follow scent on a dull, damp day than in the bright sunlight when dry air prevails, but that even this cannot be put down as a hard and fast rule. Scent may be good in the morning and bad in the afternoon, and *vice versa*, and hounds that are at fault in the morning may run hard later in the day. The powers of scent of such dogs as setters and retrievers vary greatly at different times. On a September afternoon, he says, a famous hunter shot and wounded no fewer than ten partridges, which were running in that condition, although his retriever could not find any of them. He then waited until the cool of the evening, brought her back to the same spot, and within ten minutes she had tracked down every one of the birds.

"Why," the correspondent asks, "are cats so strangely fond of valerian? Why are stoats and weasels attracted by the oil of musk?" The answer is probably entangled in sex phenomena, while his declaration that a vixen with her cubs hardly leaves any

scent behind her has at least the odor of a kind of provision of nature. When he asks, "Why are rats so keen on aniseed and rhodium?" we acknowledge ourselves beaten, more particularly in regard to rhodium. If they have such a passion for rhodium they can hardly be indifferent to platinum, and an ex-president of the Electrochemical Society suggests a real use for rats in this connection. He proposes that they be used in prospecting for platinum and as an aid to detectives in locating stolen crucibles. We wonder what the London writer wrote that the printer mistook for rhodium!

But where is the chemistry of all these curious reactions? What is scent, anyway? What happens when we smell? What are the carriers of odor? What reactions take place on the sensitive plates in the nostrils where the nerve termini are embedded in lipoid substance? What's the use in talking big about chemistry when nobody can tell us of the process of smelling? How many atoms must a molecule contain to have the olfactory quality? And how many carbon atoms mark the limit of this quality? The cellulose molecule seems to have no odor. Has it too many carbon atoms to produce the phenomenon? If we only knew how many carbon atoms the cellulose molecule contains we should know a lot more than we do now. Dr. THOMAS H. DURRANS, an English investigator, has expressed the opinion that odor is due to unsatisfied bonds within the molecule. That may be true, but the rest of us do not seem to know enough either to confirm or to deny it. The subject is unstudied, and it needs attention.

The Ways and Habits of Micro-organisms

IT WAS during convocation week at Chicago in December last that Dr. SIMON FLEXNER made his famous presidential address at the meeting of the American Association for the Advancement of Science. He called it "Twenty-five Years of Bacteriology: a Fragment of Medical Research," and we commend it to our readers as a model of scientific literature. It was published in the December 31, 1920, issue of *Science*. He began with the meeting of the German Society of Naturalists and Physicians in 1895, when the announcement was made of the conquest of diphtheria by an antitoxin. Establishing that as a landmark, he proceeded to lead up to it by a historical introduction, not for the purpose of giving dates and mentioning names, but to give, which he succeeded in doing, a clear picture of the state of the art at the time. Then followed a discussion on the high lights of what has been done since. It is a very illuminating essay, with the theory and application of science made remarkably clear.

We have published articles on the uses of micro-organisms in industrial chemistry, but we want more. We need more industrial biochemistry. The fermentation of ethyl alcohol from sugar is studied and available, but we do not know enough about the production of glycerol by a similar process or of the zymotic production of amyl alcohol from protein substances—e.g., from the germs of grains. We have hardly lifted the cover of this great treasure store of industry as yet. Elsewhere we have expressed the hope that some day the chemical factory will be as greatly desired in a neighborhood as a public library or a school. That will be when we work more delicately than we do now;

when we let the microbes do our work for us. They require great cleanliness to keep the strains pure, but when the conditions are favorable they scorn union hours or minimum wages or overtime, and they work while we sleep. The time is ripe for some FLEXNER of industrial chemistry to give us such a paper on biochemical technology or chemical biotechnology, whichever you please. True, FLEXNERS are scarce, but we are not keen about names. It is the work we are after.

Hours of Service

In the Steel Industry

THE iron and steel industry expects the United States Steel Corporation to present within a few weeks a solution of the difficult problem of the hours of service in the industry. Many years ago it became the custom in some departments to have men on duty twelve hours a day seven times in the week. Fortnightly, when the day and night shifts changed places, there was a twenty-four-hour spell. The practice was due partly to competition among manufacturers and partly to the willingness of the labor, chiefly foreign born, to work very long hours. In the Steel Corporation's annual report for 1912 it was stated that the corporation was observing the six-day week. This was accomplished by having a twenty-four-hour interval each week in the production of ingots and by giving men at blast furnaces a day off in the week in rotation. Thus the twenty-four-hour spell for a given man every fortnight was eliminated. The corporation's practice in this matter has not been universal, and at any rate the twelve-hour day has remained except at a few works.

Usually the problem has been considered as involving simply a choice between two twelve-hour shifts and three eight-hour shifts, since the machinery works continuously. Many of the men do not, but the precise time at which they may be required cannot always be predetermined, and it is requisite for full utilization of the plant equipment that the men who do not have to work continuously be subject to instant call. Many of the men prefer the long hours with the attendant pay in preference to a much shorter day with but a slight diminution in the daily earnings. The social workers recognize, as do others, the advantage to the country of shorter hours on duty and of more Americanization, but they have been disposed to place the whole task before the employers. The desire for a shorter day with opportunity in leisure hours for recreation and self-improvement, with the employee bearing a reasonable part of the expense, has not been inculcated in the minds of these workmen.

When the demand for pig iron and steel products is heavy, as in 1920 when buyers bid from three to five times the pre-war price for many classes of steel, a large curtailment in the supply would occur if the hours were shortened, because additional men could not be obtained. When, as at the present time, the iron and steel industry is faced with the necessity of producing cheaply and economically in order to make a market, without which there would be no employment at all, it is essential that the operation of production be efficient. Every man must do a fair day's work for a fair day's pay. The economics of the situation will not countenance any other condition. There is a horrible example in the case of the railroads, whose payrolls as recently constituted included about 1,950,000 persons. At five persons to a bread-winner that

meant 9.2 per cent of the population dependent on the railroad payrolls. Such a division of the sum total of the work of the people is impractical, and the iron and steel industry would be committing partial suicide, if use of such a term be permitted, if it adopted a system that did not provide a full day's work for each man on the payroll.

To leave all work to be done as it is done now and have three men per twenty-four hours instead of two men to perform the services is impractical on economic grounds, but hitherto the problem has been regarded as a mere choice between two shifts and three shifts. In view of the fact that a committee composed of presidents of subsidiary companies of the Steel Corporation has been hard at work on the subject it is a fair presumption that an elimination of the twelve-hour day is being sought by substitution of a system that will be much less inefficient on economic grounds than an eight-hour period of service, with general methods of operation unchanged. When no solution of the vexed problem has hitherto been proposed that seems economically sound, and when the Steel Corporation evidently finds the task so difficult, it is idle to speculate as to what will be the outcome of the present study, but from all the circumstances it seems fair to conclude that within a short time a system will be put into actual operation that will eliminate unduly long hours of service and yet will provide that each man does a fair day's work, so that the country will not be devoting an undue amount of its total time to the production of pig iron and steel. It is now committing such an economic crime in the case of railroading and coal mining, and would be including a third in the case of the building trades if the unions in that line had their way. The country could not stand such a collection of crimes, its duty being to reduce, not increase, the number.

Science in the

Public Service

THE National Research Council is contributing splendidly to the cause of chemistry and chemical industry by the exhibit which it is showing of the relation between chemistry and both peace-time and war-time industrial products. This exhibit, prepared largely by the Chemical Warfare Service, strikingly portrays the close relationship of explosives and material for chemical warfare to the peace-time products of the dye, pharmaceutical and other organic chemical industries. Taking coal, salt, sulphur and air, which remind us of the alchemists' elements, this exhibit shows the diversity of product which modern chemical industry furnishes for the comfort and protection of mankind. It makes one believe that the ancient alchemist was nearer the truth than most histories of chemistry would lead us to believe when he considered air, water, earth and fire as the elements. Certainly the number of truly basic substances of industry is fewer than we commonly believe, and the interrelation of industry is much closer than modern commercial practice would show.

It is to be hoped that the purpose of this exhibit will be generously realized in the education of legislators, professional men and the general public. Particularly we should like to see a keener appreciation of the great importance both in peace and in war times of that effort which is basic to the Chemical Warfare Service.

Readers' Views and Comments

Fundamentals Essential to Soundness of Steel Rails

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Jan. 26, 1921, you published a communication from George F. Comstock, metallurgical engineer of the Titanium Alloy Manufacturing Co., headed "Relationship Between Segregation and Rail Failures." On the face of it Mr. Comstock has made out a very good argument for the titanium-treated rail, but so much more data as to the service conditions of the various tests quoted are necessary before an engineer or metallurgist could draw intelligent conclusions that the whole argument loses much force and as it stands is possibly misleading.

Mr. Comstock also makes one statement of fact that I must take direct exception to. I quote: "Theoretically there is no question that the sink-head process is effective in eliminating pipe in ingots, but piping can be controlled also by care in ordinary methods of ingot manufacture. For instance, in a recent rolling of standard titanium-treated rails, the top discard averaged 8.3 per cent from the ingot, and by keeping the silicon content of the steel below 0.10 and pouring slowly, the piped rails were kept down to 4.5 per cent as determined by the nick-and-break test on every ingot. No special molds or hot-tops were used."

Does he mean by "sink-head" process the putting of a sink-head on an ordinary big-end-down ingot? This is admittedly valueless, as the sink-head only hides the secondary pipe or shrinkage, which at times occurs down in the bottom 20 per cent of the ingot. The only true value of a sink-head in producing physically sound steel is when it is used in conjunction with a big-end-up or inverted ingot mold. This has been clearly explained by Dr. H. M. Howe and so many others that it need not be reopened to argument. I feel that Mr. Comstock committed a great error in referring to sink-head ingots without stating whether the mold was big end up or big end down, thus making a statement that is at least indefinite and may readily damage the cause of physically sound steel.

As a matter of fact, the big-end-up ingot with the refractory sink-head has been in use even in this country on the highest quality sound steel products for twenty years or more, and its use is constantly growing until last year over a million tons of ingots were cast this way. This can therefore hardly be considered "theoretical."

Mr. Comstock speaks of eliminating pipe. Pipe is the volumetric shrinkage of steel when going from the molten to the solid, and of course cannot be prevented. It can only be so controlled that it will appear in a small portion by weight of the upper end of the ingot. It can only be eliminated by cropping the piped portion of the ingot.

I quote further from Mr. Comstock: "But piping can be controlled also by care in ordinary methods of manufacture."

In my understanding the only things that the steel maker can do to control pipe in ordinary methods of manufacture, using a standard big-end-down ingot, are:

First: To only partly deoxidize or not to deoxidize the steel, thus forming blowholes all through the ingot instead of pipes. Unless the object is to produce a coarse steel sponge, this is inadmissible.

Second: To roll the ingot before solidification has completely taken place, according to the plan suggested by Talbot. This produces so-called "cokey," gray or soft centers, a condition prohibited in all ordnance and high quality steel, and now prevented in the latest rail specifications. (A.R.E.A. 1920, Par. 31.)

Note B of these specifications says: "The steel must be well deoxidized and the waste products eliminated before teeming," thus definitely prohibiting the use of a steel that will form blowholes. It is only by the doing of one or the other, possibly both, of these indefensible things that ingots could be produced in ordinary molds that would give a yield of 91.7 (8.3 per cent top crop) with only 4.5 per cent of the rails showing pipe on the nick-and-break test.

It is probable that in making these estimates of percentage of crop necessary to reach sound metal Mr. Comstock has fallen into the error that so many metallurgists and the writers of so many specifications also fall into—viz., that the visual examination of the fracture of a finished part is sufficient to detect physical flaws in the metal and insure soundness.

An examination of the fracture in a nicked and broken rail does not reliably show up a cokey center, although the longitudinal fracture of the bloom from which the rail was rolled does. Hence this is where the inspection for physical soundness should be made, and it can be made at this point without interfering in any way with manufacture or adding to cost. When this is done, inspection will catch the deeply hidden flaws which at present slip by on the inspection only of the finished product and later cause such dangerous breaks as transverse fissures, shattered zones and split rail heads.

The fundamentals essential to the soundness of steel rails are:

First: That the bath of metal be thoroughly deoxidized before teeming, so that no chemical reaction can take place during solidification.

Second: That the metal be cast in an ingot mold whose inside dimensions are enough greater at the top than at the bottom to prevent internal bridging.

Third: That the ingot after teeming be kept in substantially a vertical position, either in mold or soaking pit, until solidification is complete.

Fourth: That a refractory sink-head be used on all ingots.

Mr. Comstock holds that titanium promotes soundness in that it is the best of all known deoxidizers, and that is of course his argument in the letter in question, for he says: "We have found, moreover, that no titanium-treated rail is ever segregated if the treatment has been properly made, so that there is a small residual content of titanium." This implies the complete deoxidation of the steel, as otherwise there could be no residual titanium. An important question from a commercial stand-

point which might be discussed in this connection is this:

Can steel, such as rail steel, be completely deoxidized with titanium alone when the silicon is kept down to 0.10 per cent, and what is the cost per ton of doing this? I am asking this because as I mix with steel makers I find that they are only using titanium as a partial deoxidizer in such products as sheet bar and plates, possibly others of the same class, and its effect thus used is only to deepen the location of the blowholes which form in all open steel ingots. This only hides the flaws more deeply in the steel and makes them harder for the buyer of the steel to find, but the user ultimately does find them when the part breaks in service or fails by corrosion. In my opinion this is a false and uneconomical use of titanium, though it may be commercially profitable today. Its true use, if it is to be of any permanent value in the steel industry, is either as a deoxidizer or alloy, and not as a "dope."

Segregation is always present in all ingots. It is an inherent condition in all steel which forms by selective freezing, and hence Mr. Comstock's statement that no properly titanium-treated rails ever show segregation is of course not literally true. The thing which should be said of titanium is that it retards and minimizes segregation, and this is also true of many other deoxidizers. For this reason, and also because a thoroughly deoxidized bath prevents blowholes and concentrates the entire volumetric shrinkage of the steel in one pipe cavity, deoxidation is the first fundamental essential to soundness. Mr. Comstock ought to agree with me here. Use of a big-end-up mold with a deoxidized bath of metal automatically locates all pipe and much unavoidable segregation in the upper part of the ingot, where it can be cropped and discarded, and hence the big-end-up mold is the second essential to soundness. Use of the sink-head with the first two makes it possible to crop all pipe and dangerous segregation with less than 10 per cent of the ingot weight, and therefore it is a commercial essential. Holding the ingot vertical until solid prevents cokey centers and the extremely dangerous flaws that are attendant thereto, and is therefore essential to soundness. It is my opinion that cokey centers cause more breaks in rails than all other defects put together, chemical segregation included.

Mr. Editor, I wish to call attention to your editorial of Nov. 17, 1920, headed "Why Not Turn the Mold Over?" and most positively state in support of the ideas contained there that as long as rail makers and rail users continue to compromise with the "big-end-down mold fetish," as they are still doing today, they will continue to get rails full of dangerous hidden flaws. Furthermore, if they will turn the mold over and employ the three other fundamentals essential to soundness, they can get uniformly sound rails and at no appreciably greater cost.

GEORGE A. DORNIN,

Gathmann Engineering Co.

Consulting Engineer.

Mr. Comstock's Reply

To the Editor of Chemical & Metallurgical Engineering

SIR:—In regard to the service results on titanium-treated rail, it should be understood that these were not from special tests conducted by the Titanium Alloy Manufacturing Co., with all conditions carefully controlled. They were purchased by the railroads at a

slight increase in cost above that for ordinary rails, and naturally were placed in track where the service conditions were severe so that this increase in cost might be repaid in service. If Mr. Dornin or any other interested person will take the trouble to refer to the published records of the American Railway Engineering Association he will readily see that the tonnages involved are large enough to make the various results thoroughly practical and representative of actual track conditions. It is hard to see any justification for the charge that my argument was possibly misleading, since the results originated with the railroads themselves, which would naturally be most interested in placing the titanium-treated rails where they would be exposed to service conditions more severe than the average.

Most of Mr. Dornin's criticisms seem to be the result of the brevity of my former letter, but it should be remembered that that was just a letter and not an exhaustive paper on the subject. When I mentioned the sink-head process, I of course meant this process properly used; it was not necessary to state this in detail, as my letter was in reference to Dr. Burgess' articles, where all these details were mentioned. I reiterate that piping can certainly be controlled by the way the steel is poured into the molds. In the rolling mentioned (with a top discard averaging 8.3 per cent) the ingots were completely deoxidized and not rolled with liquid centers, yet only 4.5 per cent of the rails showed pipe on the nick-and-break test. The inspection for pipe was, of course, made in the usual, standard manner specified for the nick-and-break test, and by the regular inspectors accustomed to this test. There is no question that pipe can be accurately determined in this way. There is absolutely no reason why a soft center in a rail should be confused with unsoundness, and there is no published evidence known to me that a soft center ever did a rail any harm or caused a transverse fissure, a shattered zone or a split head. I have examined quite a number of failed rails, and have carefully studied all other reports of such examinations that I could find, and have never found any case of trouble caused by a soft center. Most failed rails, on the other hand, are segregated and have a hard center.

In reply to Mr. Dornin's question about deoxidizing rail steel, our experience with thousands of tons of this steel shows that it can be deoxidized completely by the usual manganese addition, silicon in an amount giving from 0.06 to 0.10 per cent in the final steel, and 13 lb. of ferrocaboron-titanium per ton. The cost of ferrocaboron-titanium is 10c. per lb., making the actual cost of the treatment \$1.30 per ton, in rail steel. In soft steel, such as for sheet-bar and plates, this is probably not true. In this class of material experience shows that effervescing steel gives the best results, so that titanium is generally used in it as a partial deoxidizer and cleanser. This use is giving improved results in many mills, which is a stronger argument for using it than mere opinion. In most of this steel a good clean surface is the important point, and it has yet to be shown that a good surface implies hidden defects causing breakage or corrosion in service.

The quotation from my letter about "no properly titanium-treated rails ever showing segregation" is another instance where a phrase isolated from its context may have an unintended meaning. In connection with the table and paragraph where this statement occurred

in my letter, it should be apparent that by "segregated rail" I meant one with over 12 per cent segregation of carbon between the upper corner of the head and the junction of head and web.

I have always been a supporter of the Gathmann mold, and believe that its use will produce better ingots with less waste than the ordinary molds produce; but it is the deoxidation of the steel, and not the type of mold used, that controls or minimizes segregation, which when uncontrolled is the cause of more rail failures than any other defect.

GEORGE F. COMSTOCK.

Metallurgical Engineer.
Titanium Alloy Manufacturing Co.

Easy Money From Peat

To the Editor of Chemical & Metallurgical Engineering

SIR:—I happen, unfortunately, to be the "Charlie" you mention so many times in your story on "Easy Money From Peat" in your issue of Feb. 2, and can say that every word in it is the truth. If your gentleman would have stayed or waited until called back by the Professor after being ordered out of the basement and witnessed the second demonstration quickly staged by the inventor you would have had a complete story and not part of one. What I saw accidentally, as I could not very well be ordered out with the others, though it was against the Professor's wishes to have me stay, I could not very well write, as I would not like to sign my name to it, as it might be going too far. I resigned that evening as secretary and treasurer of the company, so you might imagine what I saw was not very pleasant. George and myself happen to be too honest young men full of ambition; and as the Professor promised us a lot and we having no knowledge of chemistry, we took a chance, thinking the Professor and his process were straight.

EDITOR'S NOTE. For obvious reasons the name of our correspondent is omitted. The communication is valuable, however, in support of the statements made in our article. It has been brought to our attention that some of our readers believed the article to be a figment of the imagination, but we wish to assure them that it was a statement of fact.

Research, a Capital Investment or an Operating Expense?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with a great deal of interest and approval what is written under the caption "Research, a Capital Investment or an Operating Expense?" in your issue of Feb. 2. On some of my advertising matter I have carried for a number of years the following: "Money expended for professional advice is capital invested, and should be so entered on the books." Credit for this eminently safe and sane dictum is given to the *India Rubber World*.

It seems to me that a great many managers of industrial enterprises fall into two very serious economic errors. The first is that of considering an expenditure as synonymous with expense, while the second is that of regarding a reduction of expenditures as necessarily an economy. England's great Prime Minister Disraeli years ago said: "True economy does not consist in a reckless reduction of expenditures; on the contrary, such a course almost inevitably results in increased expense—there can be no economy where there is no efficiency."

If there ever was a time when it would be profitable

to display a wise liberality in expenditures to promote industrial efficiency, to increase the buying power of money by a careful inspection of all material bought, and, above all, by a rigid supervision showing how material is used, this is the time above all other times. In the case of fuel, for instance, selling as it does at such enormously high prices, what economies might be effected if its use were under the continuous supervision of competent fuel engineers!

It appears, though, that the editor of *Drugs, Oils and Paints* was about right when he said many years back: "It would seem that the average American manufacturer prefers to go to his ruin on his own responsibility rather than to go to success by the aid of outside help." Going still further back, one Lucius Æmilius Paulus said in 165 B.C.: "I would call that man more proud than wise who attempted to do everything by his own unaided judgment."

Since the days of this old Roman men have probably grown more proud. Have they, in matters of industrial efficiency, grown very much wiser?

Baltimore, Md.

WILLIAM N. BERKELEY.

The Hargreaves-Bird Electrolytic Cell

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read J. B. C. Kershaw's description of the Hargreaves-Bird cell, as appearing in your issue of Jan. 12, 1921, with interest, as certain of the information contained therein is new to me. But I would particularly refer to his remark that "this company has been operating under the war conditions of inflated prices." I have always taken interest in so-called derelict companies and processes, and I have been fortunate enough in being able to show, on more than one occasion, that such companies and processes have been wrongly described. A very large number of experts considered the Hargreaves-Bird cell was a failure and pointed to the misfortunes of the Electrolytic Alkali Co., Ltd., as a proof of their theory, and it seems to have annoyed them considerably to find that their views have been proved incorrect. Some of them, unfortunately, are not generous or broadminded enough even now to admit that they were wrong.

In September, 1916, the Ministry of Munitions decided, after going into details of cost, that a fair price for bleaching powder made under a certain process was £10 per ton, but because our process was more efficient the price they would pay us would be £7 10s. per ton. The Ministry of Munitions did not alter that price until January, 1918. During this period it is obvious that the cost of labor, raw material, etc., increased to a considerable extent, and it was only by continuous improvement that we were able to maintain the margin of profit. Had we been able to sell our bleaching powder on the open market we should have got, during the latter part of this period, anything from £25 to £40 per ton. Further, we were pleased to assist in making certain poison gases, and we did this at net cost of labor and material, plus a small percentage, which percentage was very much below our standing charges. Obviously, therefore, there was no profit for our organization under this head.

The above will show that the prices we got for our products, to say the least of it, were not inflated prices.

ELECTRO BLEACH & BY-PRODUCTS, LIMITED,

S. HUTCHINS,

Managing Director.

Middlewich, Cheshire, England.

Atoms and Metals

Summary Outline of Modern Views of the Ultimate Constitution of Matter — Nature of Forces Existing Between Atoms in Gas, Liquid and Crystalline or Amorphous Solid as Affecting the Commonly Measured Physical Properties of Metals

BY ZAY JEFFRIES AND R. S. ARCHER

Research Bureau, Aluminum Company of America

DEVELOPMENT of metallographic science is evident in the direction of a thorough study of the constitution of matter. The microscope has revealed structures in metals unsuspected by the naked eye, and has made intelligible much of the behavior of metals which was formerly quite mysterious. The range of the microscope is limited, however. We know in many cases that structural changes are taking place on a scale so minute as to lie beyond the resolving power of the microscope and yet are producing revolutionary changes in the properties of the metal. Since the study of the structure of metals with the microscope has yielded results of such great practical value, we may expect that the extension of this study to those details of structure which lie beyond the resolving power of the microscope will result in a corresponding extension of our useful knowledge of metals.

In the complete analysis of structure we are concerned with the ultimate particles of matter—the electron, atom and molecule. It is not sufficient merely to recognize that such particles exist and that the atom is an extremely small particle of matter which is the unit of chemical combination. We must gain some appreciation of the actual sizes of these particles, of their properties, and their relations with one another. In this way a mental picture can be formed of the manner in which metals are built up and of the mechanism of the changes in structure and properties which affect their utility. The knowledge of the ultimate particles which is now available is not enough to make our pictures entirely complete and accurate, but it is enough to make them useful.

CONSTITUTION OF ATOMS

The electron has the smallest mass of any particle of which we have any knowledge. The word "electron" was first suggested in 1891 by Dr. G. Johnstone Stoney as a name for the natural unit of electricity, or a unit electrical charge (4.77×10^{-10} electrostatic units). It is now almost universally applied to certain very small particles which possess a definite mass and carry a single negative electric charge. It is quite possible that the mass of the particle is entirely of electrical origin, and that the unit electrical charge actually constitutes the particle. The mass of the electron is about $\frac{1}{1800}$ that of the lightest known atom—namely, the atom of hydrogen. Assuming that this mass is entirely of electrical origin, it can be calculated that the radius of the electron is about 2×10^{-12} cm. Experimental evidence shows that the size of the electron is actually of this order of magnitude, which is very small as compared with the diameter of an atom. Because of their negative charges, electrons are to be regarded as repelled by each other and attracted by positive electrical charges.

It is now considered quite certain that atoms are built up of negatively charged electrons grouped about positively charged nuclei.¹ The charge on the nucleus of an atom is exactly balanced by the negative electrons surrounding it, so that the atom as a whole is electrically neutral. Independent methods of experiment have estimated the exact number of electrons in the atoms of the various elements. If the elements are arranged in the order of increasing atomic weight and numbered consecutively from 1 to 92, with a few omissions, the numbers thus assigned are called the *atomic numbers* of the elements. According to this conception the atom of each element has a number of electrons equal to its atomic number; thus hydrogen has 1, helium 2, iron 26 electrons, etc. Fundamentally, different kinds of atoms owe their individuality to their positively charged nuclei; the charge on the nucleus evidently determines the number of electrons which will be held about it by electrostatic attraction. These electrons will naturally group themselves into some most stable arrangement which must be different for different numbers of electrons. Atoms of the various elements differ therefore in the character of their nuclei, and the number and arrangement of electrons.

ATOMIC MASS AND VOLUME

The mass of an atom is due almost entirely to its nucleus. A hydrogen atom contains only one electron, having a mass approximately only $\frac{1}{1800}$ that of the atom, while the atom of uranium, which contains 92 electrons, has a mass about 236 times that of the hydrogen atom. In the latter case the contribution of the negative electrons to the total mass is still more insignificant. The total mass of the atom increases with the charge on the positive nucleus, but not in a perfectly regular manner.

The actual mass of the hydrogen atom has been determined and has a value of 1.662×10^{-24} g.; its atomic weight is 1.008. If we imagine a hypothetical element with an atomic weight of unity, the mass of its atom would be 1.643×10^{-24} g. The actual mass of the atom of any chemical element is the product of its atomic weight by the mass of this hypothetical atom. For example, the mass of an iron atom = $55.84 \times 1.643 \times 10^{-24} = 9.174 \times 10^{-23}$ g.

The size of an electron is known to be very small as compared with the volume dominated by the atom of which it is a part.² The radius of the latter volume is probably of the order of 50,000 times the radius of the electron. It is believed that the heavy posi-

¹Langmuir and Lewis have recently developed a general hypothesis regarding the positions of electrons in atoms and molecules which promises to be very far reaching. For a clear exposition of this theory see "The Langmuir Postulates," by Ellwood Hendrick, CHEM. & MET. ENG., vol. 21, p. 73, July 15, 1919.

²"The Electron," R. A. Milliken, Chicago University Press.

tively charged nucleus of the atom is still smaller than the electron. An atom consists, therefore, chiefly of empty space. It is possible to project one atom through another without striking the nucleus or any of the electrons in much the same way that a comet might shoot through our solar system, without striking the sun or any of the planets.

In view of the open nature of its structure, an atom cannot be said to possess a definite volume, in the sense of a space inclosed by a bounding surface, but in any given material we can determine the volume per atom, which we may for convenience call the volume of the atom, always recognizing that we mean merely the volume dominated by the atom, or its "sphere of influence." In this sense it is quite simple to calculate the volume of an atom from its mass and the density of the element. Taking iron again for an example, the density is 7.87 g. per c.c. The number of atoms in 1 c.c. is then

$\frac{7.87}{9.176 \times 10^{-24}}$; the reciprocal of this number is the volume per atom, and figures 1.166×10^{-23} c.c. This calculation depends of course on the value taken for the density of iron, which varies with the temperature, pressure, and arrangement of the atoms—i.e., physical form. Therefore the volume of an atom in this sense is not a constant property of the atom like its mass. A set of numbers representing the relative volumes occupied by atoms is obtained by dividing the atomic weights of the elements by their densities when in the solid state. Physically, the number thus obtained gives the volume in cubic centimeters of an atomic weight in grams (gram-atom) of the solid element, and is called the *atomic volume* of the element.

VISUALIZING THE SIZE OF ATOMS

It is difficult to imagine the size of such small objects as atoms. Tungsten, for example, which has a specific gravity of slightly over 19, requires about 100,000,000 atoms as they are normally spaced at room temperature to make a linear inch. A 1-in. cube of tungsten would, therefore, contain about 1,000,000,000,000,000,000,000 or (10^{21}) atoms.

We are in the habit of visualizing all objects in terms of things which we can see with the unaided eye—e. g., we make a map of as large an area as the continent of North America and reduce it to such an extent that we can see its general geographical characteristics on one page, or one map. On the other hand, we magnify objects too small to be seen with the unaided eye to such an extent that we can see the photograph or other physical likeness with the unaided eye. We cannot visualize the size of an atom, owing to its smallness, but we can gain some idea of the ratio between atomic dimensions and one of the smallest units which can be readily seen with the unaided eye—namely, 0.01 in. Let us suppose that instead of atoms we have spheres 0.01 in. in diameter. Let us further suppose that we make up a cube composed of 10^{21} of these spheres closely packed. This cube would be 1,000,000 in. on a side, or over 15 miles. Consequently, the diameter of a tungsten atom is to 1 in. as 0.01 in. is to 15 miles, and the space dominated by a tungsten atom is to 0.000001 cu.in. as 0.000001 cu.in. is to 225 cubic miles. This comparison may be equally difficult to comprehend, but it at least calls strikingly to our attention the very small dimensions of the atoms.

INTERATOMIC FORCES

Atoms exert upon each other both attractive and repulsive forces. Thus, metallic iron is an aggregate of crystals built up of atoms arranged in a definite manner, and any attempt to separate these atoms from each other, as by the application of a tensile load opposed by the cohesion of the metal, which results from the attraction of the atoms for each other. A small tensile load such as 3,000 lb. per sq.in. is applied, the distances between atom centers in the direction of the load increase by a certain amount in accordance with the elastic modulus—in the case in point, 0.01 per cent. On removal of the load the atoms return to their original positions.

Similarly the atoms are moved closer together by hydrostatic pressure, resisting the pressure because of the repulsive forces between them. When the pressure is released these forces restore the atoms to their original positions.

Atoms of a solid are thus held in equilibrium positions by a balance of their forces of attraction and repulsion. On being forced closer together the repulsive forces increase more rapidly than the attractive forces and the resultant force is a repulsion which varies approximately as the displacement of the atoms from their equilibrium positions. When the atoms are pulled farther apart than their equilibrium positions, the resultant force is attractive and again is approximately proportional to the displacement of the atoms from their equilibrium positions.

At all temperatures above absolute zero the atoms of the solid elements are in a state of vibratory motion about their equilibrium positions. The frequency of vibration is on the order of 6×10^{13} cycles per second, and does not vary greatly with the temperature; the amplitude of vibration does increase with the temperature, however, thereby increasing the kinetic energy of the particles. In fact, *temperature* is a term used to indicate the mean kinetic energy of the particles of a body.

All of the common properties of a body change with the temperature except the mass. This must be due to the changing motion and energy of the atoms, since the specific properties of the atom itself do not appear to be affected by temperature. The property of radioactivity, for example, seems to be a characteristic property of certain atoms and does not vary with temperature. Similarly, the spectra of the elements exhibit an independence of temperature, again indicating constancy in the properties of the atom.

The phenomenon of crystallinity is evidence of a natural orderly arrangement of atoms. A crystal is made up of atoms held together by attractive forces which must necessarily be exerted in definite directions to give rise to the geometrical symmetry of the crystal. No element is known which does not occur in crystalline form, both in the pure state and in chemical combination with other elements. The X-ray spectrometer is constantly giving proof that many substances, once considered amorphous, are in reality crystalline and are built up of atoms arranged in definite and repeating patterns.³

This property of exerting force *directionally* is therefore a characteristic property of atoms, and because

³Important results derived during the last decade by X-ray analysis will be discussed in a later contribution on the structure of metals.

of the directional quality of the forces between atoms, the crystalline form is the normal form of matter in the solid state.

MOLECULES

Certain groups of atoms held together by atomic forces constitute molecules. Hydrogen, for example, consists of discrete particles, which we call molecules, each one made up of two hydrogen atoms. Hydrogen in the atomic state is an extremely active substance, combining with explosive violence with many elements, such as oxygen and chlorine. When the atoms of hydrogen unite with each other in pairs to form hydrogen molecules, the attractive forces about the atoms are largely satisfied. Molecular hydrogen is accordingly a very inert gas. Hydrogen molecules have little attraction for each other, as is shown by the very low boiling point of liquid hydrogen. It can be mixed with oxygen at ordinary temperatures without any reaction taking place. But when the mixture is heated some of the molecules are dissociated by the thermal impacts, and the atoms thus freed start the chemical reaction. The heat liberated continues the process of dissociation so that the reaction rapidly becomes complete.

Equal volumes of gases under similar conditions of temperature and pressure contain equal numbers of molecules (Avogadro's law). From this law the number of atoms to the molecule of a gas can be determined by measuring the density of the gas under definite conditions of temperature and pressure. Such measurements show that the molecules of the non-metallic elements in the gaseous form contain two or more atoms, with the exception of the inert gases of the helium group, which are monatomic. Atoms of the rare gases apparently do not exert sufficient attractive force to combine into molecules. Vapors of the metals also contain only one atom to the molecule.

Atoms of such elements as oxygen and chlorine exert upon each other definite attractive forces which cause them to unite in pairs to form fairly inert molecules. These molecules, as long as they are undissociated, behave very much like the atoms of the rare gases. The attractive forces of the atoms are so nearly satisfied by their combination with each other that the molecules do not condense to form liquids until low temperatures are reached.

Molecules of such chemical compounds as exist in the gaseous state must of course contain two or more atoms. As a rule the molecular formula is the simplest that can be written—that is, the molecule contains only one atom of that element which is present in the lowest atomic concentration. Molecular formulas of water vapor and hydrochloric acid, for example, are H_2O and HCl , instead of some multiple such as H_2O_2 or H_2Cl_2 . The attractive forces which make the atoms of these elements, hydrogen, oxygen and chlorine—unstable and disposed to double up in pairs—are satisfied by the chemical combination with each other.

In the accompanying Fig. 1 is shown schematically the arrangement of

the sodium and chlorine atoms in a crystal of sodium chloride, as determined by the X-ray spectrometer. Each sodium atom represented by a black circle is surrounded by six equidistant chlorine atoms represented by white circles. Similarly each chlorine atom is surrounded by six equidistant sodium atoms. If solid sodium chloride is heated sufficiently, evaporation takes place, the atoms leaving the surface in pairs in the form of sodium chloride molecules. It is evidently not possible to say which of six similarly related chlorine atoms will pair off with any particular sodium atom in the process of evaporation. The molecule of sodium chloride does not exist, as such, in the solid state.

In sulphur crystals the atoms are found to be arranged in a lattice structure in groups of eight. It is significant that these groups contain the same number of atoms as are found in the molecules of sulphur vapor. It seems certain that these groups of eight atoms must retain their identity throughout the changes of melting and boiling.

From the two examples just given it is apparent that the definition of a molecule in the solid state is difficult. In many substances like sodium chloride there is apparently no unit which can be called a molecule unless we call the whole crystal a molecule. Metallic elements all fall in this class. On the other hand, in sulphur and in a large number of chemical compounds, the solid crystal contains certain groups of atoms which may be regarded as molecules.

CHEMICAL FORCES

It has been customary to distinguish rather sharply between the chemical force called "affinity" and the physical forces of cohesion, adhesion, surface tension, etc. On considering the structure of the sodium chloride crystal, it is evident that the forces which are responsible for the cohesion of the crystal are the chemical forces, or the "affinity," between the sodium and the chlorine atoms. This is merely one example of a large mass of evidence which is forcing us to the conclusion that the physical and chemical forces between atoms are of the same nature and that there is no justification for a sharp distinction between them.⁴

The chemical forces which hold atoms together in the form of distinct molecules are very definite in respect to the number of atoms held in combination. An atom's combining capacity is expressed by the term valence; hydrogen possesses unit combining capacity, it is always held to have a valence of 1. Furthermore, the valence of hydrogen is considered to be positive, while that of the elements with which it combines is considered to be negative, at least in respect to hydrogen. Any element which can replace hydrogen in its compounds is also said to have a positive combining capacity. Oxygen is the standard for negative valence, having a combining capacity of 2, since one atom of oxygen combines with two atoms of hydrogen. These are simply the ordinary rules of valence, into which it is not necessary to go at further length here.

Simple molecules formed in accordance with these rules often combine with one another to form more complex compounds; typical examples are hydrated salts, and silicates. The numbers of molecules of each kind involved in these combinations are quite definite, but are not indicated by the ordinary rules of valence.

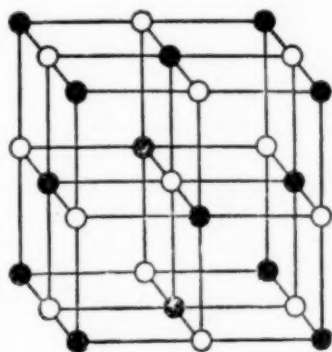


FIG. 1. SIMPLE CUBIC ARRANGEMENT STRUCTURE OF SODIUM CHLORIDE CRYSTAL

⁴"The Constitution and Fundamental Properties of Solids and Liquids," Irving Langmuir, *Journal, American Chemical Society*, 1916 and 1917.

There is nothing in the valence of the elements to account for the number of molecules of water in definite hydrates $\text{NaCl} \cdot 2\text{H}_2\text{O}$; $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 12\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 7\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 5\text{H}_2\text{O}$ and $2\text{FeCl}_3 \cdot 4\text{H}_2\text{O}$. Ferric chloride forms a number of distinct hydrates, an illustration of a general tendency for molecules to combine with each other in several different ratios, each definite but apparently unrelated to the valences of the constituent elements or to each other.

Compounds of this type are usually limited to the solid state. Any attempt to volatilize a hydrated salt results in the decomposition of the compound, the water molecules and the salt molecules leaving the solid separately. There is no such thing as a distinct molecule of the hydrate itself, consisting of a definite number of atoms. The "molecule" in the solid state is the entire crystal, which is built up of its simple constituent molecules arranged in definite space lattices. The numbers of the different kinds of molecules which combine with each other in such arrangements depend upon geometrical considerations and not upon any definite combining capacity or valence characteristic of each molecule.

PRIMARY AND SECONDARY VALENCE

The forces which cause atoms to combine in definite proportions to form distinct molecules may for convenience be termed "primary valence" and the forces which unite these molecules into crystalline aggregates may be called "secondary valence" or "residual valence."

Secondary valence forces may serve to unite like molecules as well as unlike molecules. Thus, ice is built up of H_2O molecules. Two atoms of hydrogen are held to one oxygen atom in this group by primary valence. These molecules are then united by secondary valence in the crystal of ice. Ice is here not regarded as a distinct chemical compound, but merely as a different form of water; its formation from H_2O molecules is, however, a phenomenon of the same type as the formation of crystals of $\text{NaCl} \cdot 2\text{H}_2\text{O}$ from NaCl and H_2O molecules. The forces are equally chemical in nature.³

Molecules of the elements are primary valence compounds. The valence of an element toward other elements does not tell us how many atoms combine to form the molecule, but other considerations lead us to classify the forces involved as primary valence forces. The very existence of the molecule as a discrete particle passing probably unchanged through solid, liquid and gaseous states is typical of a primary valence compound. The heat of formation of molecules from like atoms is of the same order of magnitude as in the case of molecules formed from unlike atoms—that is, chemical compounds. The heat of formation of molecular hydrogen from atomic hydrogen, for example, is about 80,000 calories per gram-molecule. Heat evolved in reactions due to secondary valence is in general very much smaller and corresponds in magnitude with heats of fusion and evaporation.

Elements in the solid state are normally crystalline aggregates of the molecules of which they are constituted when in the gaseous state. Sulphur crystals are built up of molecules containing eight atoms each. Metallic elements are, as far as is known, monatomic in the gaseous state; accordingly the unit of which crystals of solid metals is constituted is an atom. The forces holding these atoms together are similar in kind to those uniting the molecules of sulphur in crystal-

line sulphur and the molecules of water in ice, the forces of secondary or residual valence.

COMPOUNDS BETWEEN METALS

Metals frequently form definite chemical compounds which are important structural constituents in alloys. It is a conspicuous characteristic of these compounds that their compositions are seldom indicated by the rules of primary valence. Probably the most important compounds of this class are Fe_3C and CuAl_2 . It is of course possible to write structural formulas after the manner of organic chemistry in which the ordinary rules of valence are satisfied. Thus the constitution

of CuAl_2 might be represented by the formula $\text{Al} \begin{array}{c} \diagup \text{Cu} \diagdown \\ = \text{Al} \end{array}$. This would indicate that the crystals of this compound are built of molecules as units in the space lattice. It is probable that such is not the case, but that the units of the crystal lattice are the atoms of copper and aluminum arranged in definite and repeating patterns in which the atoms of copper and aluminum are not interchangeable. Since atoms of a pure metal do not combine with each other to form molecules, it seems quite likely that the atoms of two metals, which though different are nevertheless of generally similar chemical characteristics, likewise do not form primary valence molecules. Neither is the formation of intermetallic compounds accompanied by the large heat evolutions which so often accompany primary valence reactions. Furthermore, no intermetallic compounds are known to exist in the gaseous state, except for such feebly metallic compounds as the hydrides of antimony, arsenic and bismuth. These hydrides are composed of discrete molecules whose constitution is represented satisfactorily by the simplest possible formula based on the ordinary rules of valence. Therefore, the majority of intermetallic compounds seem to be secondary valence compounds whose compositions are determined by geometrical considerations such as the sizes of the atoms and the directional properties of their force fields, just as in the case of the hydrates discussed above.

MECHANISM OF SOLIDIFICATION

Liquids as well as solids must be held together by secondary valence forces. Gases consist of molecules in such a violent state of thermal agitation that the attractive forces between them are not strong enough to cause even temporary combinations. In the liquid state the energy of thermal agitation has decreased to such an extent that the collisions between molecules result in the formation of groups held together by secondary valence. Further collisions break up these groups so that their existence is only temporary and in actual time extremely brief. Liquids owe their fluidity to this constant shifting in the bonds between molecules. As the temperature is further lowered, the life of these molecular groups and the average number of molecules in them increase. Finally a point is reached at which the thermal energy of the individual molecules is not great enough to free them from the attraction of other molecules, and solidification takes place. The expansion of water which takes place on cooling from 4 to 0 deg. C. suggests the formation in the liquid of considerable molecular groups having the increased volume characteristic of crystalline ice. The metal bismuth also expands on solidification and we should therefore expect a slight expansion of the liquid immediately before solidification.

as in the case of water, or at least a decrease in the rate of fluid contraction.

The constriction of thermal motion can be accomplished by an increase in external pressure as well as by a decrease in temperature. If solidification takes place with a decrease in volume, as is the case with all the common metals except bismuth, the application of external pressure hastens solidification—that is, causes it to take place at a higher temperature. When solidification is accompanied by expansion, increase in pressure lowers the freezing point, but the actual changes in freezing point caused by changes in pressure are very slight.

We may review this discussion by the consideration of an example. Let us suppose some metallic tin is heated to a temperature of 2,500 deg. C. Under normal atmospheric pressure the tin will be in the gaseous state, since it boils at about 2,270 deg. C. To the best of our knowledge the gas is monatomic—that is, the molecules consist of single atoms. These atoms are in constant motion in straight lines, interrupted only by collisions. Each atom is surrounded by a field of force which attracts it to the other atoms with the same intensity as in the solid state. The kinetic energy, both of translation and rotation, overcomes the attractive forces, and no combination of atoms takes place. On cooling, this kinetic energy decreases until the attractive forces sufficiently overbalance it to cause the condensation of the gas to a liquid. Since the volume change is very much greater on passing from the gaseous to the liquid state than on passing from the liquid to the solid state, the effect of pressure on the boiling point is very much more marked than on the melting point. In liquid tin the atoms are held together by cohesion bonds of the secondary valence type, constantly breaking and re-forming, so that the positions of the atoms with reference to one another are not fixed. The liquid is therefore mobile, and can change its shape indefinitely without losing its continuity.

The atoms of tin are constantly tending to orient themselves into a regular pattern, a tendency which is

opposed by the energy of thermal motion. When this energy is sufficiently reduced, by cooling to 232 deg. C. the orienting or crystallizing tendency gains the ascendancy and solidification takes place. Solidification is identical with crystallization, or the arrangement of atoms into positions fixed with relation to each other. The atoms remain in a state of vibration about their equilibrium positions, but have probably lost their energy of rotation. On further cooling the amplitude of vibration decreases, causing a contraction of the metal. As the kinetic energy of the atoms decreases and they become closer together, it requires a greater external force to separate them—that is, the cohesion increases.

Crystals which form on solidification grow outward from nuclei until they meet each other along surfaces which are necessarily irregular. Some of the molten tin remains between the crystals in an unoriented or amorphous condition. On cooling to room temperature the motion of the atoms of the amorphous metal decreases to such an extent that the material, although possessing many of the structural features of a liquid, becomes rigid and is in effect a solid. However, the atoms retain their ability to change their position with relation to one another, and the substance is therefore capable of flow. Transition from a liquid to an amorphous solid is gradual and there is no sharp freezing point and no heat of solidification; an amorphous solid is doubtless an undercooled liquid.

COMPRESSION

T. W. Richards³ has pointed out that the attractive forces between atoms act in many ways like the application of external pressure. "There is strong evidence that where affinities are great the atomic centers come closer together, and that where the affinities are slight they are further apart." Richards considers the atom as including the entire "sphere of influence," or space

³"The Present Aspect of the Hypothesis of Compressible Atoms," Theodore W. Richards, *Journal of the American Chemical Society*, December, 1911.

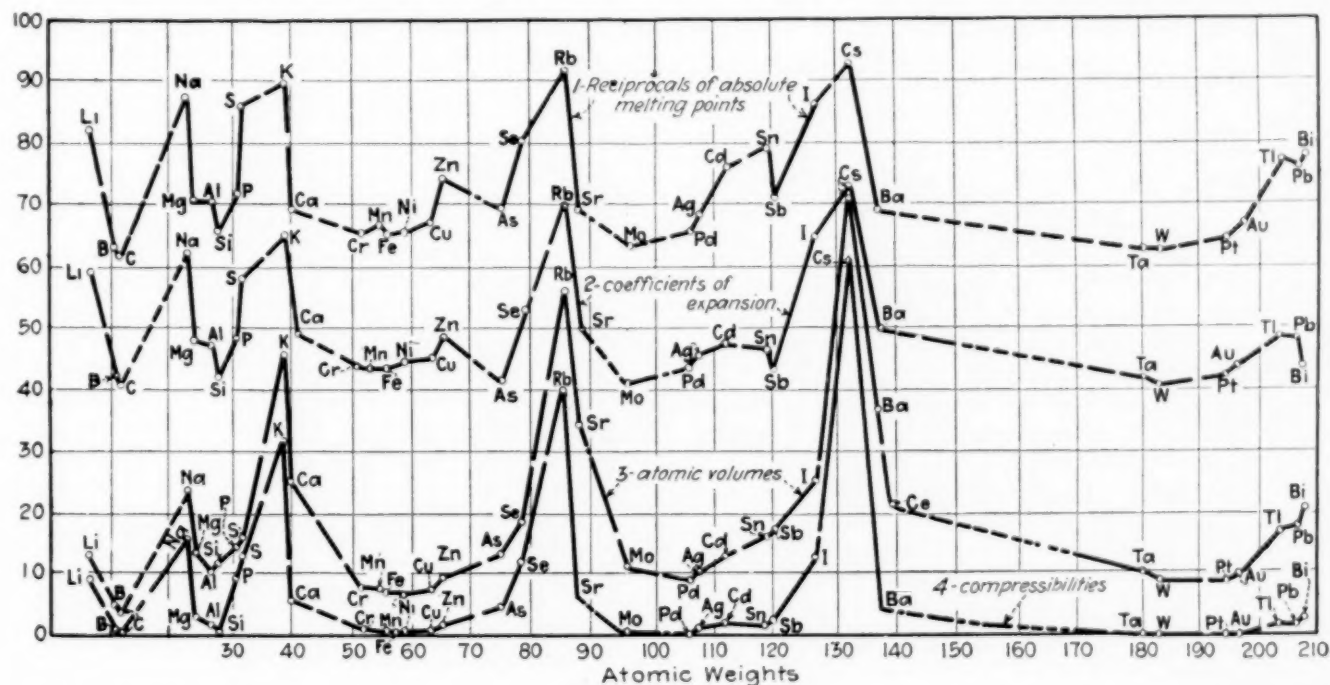


FIG. 2. RELATION BETWEEN MELTING POINTS, THERMAL EXPANSIONS, ATOMIC VOLUMES AND COMPRESSIBILITIES OF THE ELEMENTS (ACCORDING TO T. W. RICHARDS)

dominated by the atom. On this basis atoms must necessarily be regarded as compressible in order to account for the compressibility, expansibility, etc., of solids. The volume of an atom is then a definite quantity, depending on the pressure to which it is subjected.

This pressure may arise from external forces or from interatomic attraction. In the latter case it is spoken of as an internal pressure, and substances held together by strong affinities are said to be under high internal pressure. A striking example of compression by chemical affinity is found in the case of potassium chloride. The atomic volume of potassium is 45 (c.c. per gram-atom) and the molecular volume of KCl is 37 (c.c. per gram-molecule). In the compound the potassium atom and the chlorine atom together occupy less space than does the potassium atom alone in solid metallic potassium. This contraction is held to be due to a high internal pressure caused by the strong affinity of potassium for chlorine.

Small atomic volume is thus evidence of high internal pressure, which should be accompanied by great cohesion. The same forces that resist the separation of atoms by mechanical tension also resist their separation by thermal agitation, therefore small atomic volume should in general indicate low coefficient of thermal expansion, high boiling point and high heat of vaporization; such assumptions are verified in a most remarkable way in the diagram,* Fig. 2, collecting the experimental evidence now available.

The volume of any substance is diminished by the application of hydrostatic pressure. If we suppose all solids to be inherently under internal pressure, then the actual effect of a given absolute increment of external pressure, such as 1,000 lb. per sq.in., must be greater the less the initial internal pressure. The fixed increment of pressure will be effective in proportion to its ratio to the total internal plus external pressure on the substance, and those elements whose internal pressures are low, as shown by high atomic volumes, should have high compressibilities.

INFLUENCE OF ATOMIC VOLUME ON THE CONSTANCY IN COMPRESSIBILITY

"In a system already under great pressure each small successive addition of pressure will be nearly the same percentage of the whole, and therefore each like addition would be expected to have very nearly the same effect upon the volume. On the other hand, if the substance is under small pressure, each successive equal addition of pressure will be a much smaller percentage than the preceding and would, therefore, have a greatly diminished effect upon the volume. Thus, if the compressibility decreases greatly with increasing pressure, one may infer that but little pressure was present in the first case, but if a body possesses a small compressibility which is nearly constant over a wide range of pressure, we should feel obliged to believe that a great internal pressure was already present in some form within the substance." Accordingly, substances which, like carbon, silicon, iron, etc., possess low atomic volume and low compressibility, should also show considerable constancy in compressibility with varying pressure.

These relations are actually found to hold with considerable regularity in the case of elementary sub-

stances, and, "Consistently, elements with great atomic volumes also show, in general, great volatility, great compressibility, great coefficient of expansion, and great change of compressibility with increasing pressure."

Cleveland, Ohio.

Chemical Warfare Exhibit in Washington

THE importance of chemistry in national defense and industrial independence is strikingly shown in an exhibit in the offices of the National Research Council in Washington, D. C. The exhibit was arranged by the Chemical Warfare Service and will be open to the public for a month or six weeks. After that time it is proposed to take it to Philadelphia and New York.

While most chemists and some of the United States Army officials realize that chemistry as applied to warfare is the most powerful of all modern weapons for national defense, the country at large—the average citizen—is apparently ignorant of this fact. To the average layman chemistry is a jumble of incomprehensible names and symbols, and chemical warfare is associated in his mind with hideous atrocities. Up to this time scarcely any effort has been made to educate the public not only as to the value of chemistry in national defense but also as to its importance in peace time. It is the purpose of this exhibit to assist in eliminating the false impressions that prevail and to show by novel graphic representations how national prosperity is dependent on the proper development of the chemical industries and how these industries in time of war provide the only adequate means of national defense.

The main feature of the exhibit is a topographic model (Fig. 1), 7 x 12 ft., of an idealized group of chemical industries whose development and maintenance are essential for adequate national defense. The outer portion of the model shows the plants and equipment required for the production of some of the more important crude materials which are required by the chemical industries. This includes models of sulphur wells; a sulphuric acid plant; a coal mine with the usual equipment for sorting and handling coal; a byproduct coke oven with stills and storage tanks for the various crude products obtained from coal tar; a hydro-electric power plant which supplies electric power to a plant for the production of nitric acid from atmospheric nitrogen and also to an electrolytic chlorine plant from which caustic soda and chlorine are produced by the electrolytic decomposition of salt; and salt wells which provide the salt for the chlorine plant.

This group of plants surrounds what may be called the heart of the chemical industry—that is, the plants which produce the intermediate and finished chemical products. The group of buildings representing the production of the intermediate chemicals is situated near the center of the model. Radiating from the intermediate chemical plant are four separate groups of factory buildings. One group represents an industry for the manufacture of dyes; another for explosives; another for pharmaceuticals and medicinals, and another for war gases. All of these four industries use the same chemical intermediates for the production of their finished products.

Back of this model are four charts (Figs. 2 to 5) showing some of the intermediates and finished products obtained from each of the four crude chemical materials—sulphur, salt, coal, and atmospheric air. On

*From an article by T. W. Richards on "The Compressibilities of the Elements and Their Relations to Other Properties," *Proc. National Acad. Sciences*, vol. 1, p. 411, July, 1915.



TOPOGRAPHIC MODEL SHOWING THE INTIMATE RELATION BETWEEN THE COAL TAR AND OTHER INDUSTRIES

Sulphuric Acid Plant Coal Mine Byproduct Coke Ovens Nitric Acid Plant Hydro-Electric Power Plant Chlorine Plant
Sulphur Wells Explosives Pharmaceuticals War Gases Dyes Salt Wells

these charts actual samples of the chemical substances are attached.

Other features of the exhibit are samples of the material used in chemical warfare, such as gas shells, gas masks, Stokes mortars, Livens projectors, complete collections of all the war gases used in the late war, samples of pharmaceuticals, medicinals, perfumes and dyes, with various dyed materials. All the products exhibited were made in the United States.

Another feature is a collection of models illustrating the arrangement of atoms in the molecules in various coal-tar products, thus showing the chemical similarity of dyes, war gases, explosives and pharmaceuticals. Examples of these models are given in Fig. 6, which illustrate the chemical structures of carbolic acid and picric acid respectively. This shows the similarity in the structures of these two chemicals and simplifies the explanation necessary to show the non-chemist how picric acid is produced from carbolic acid.

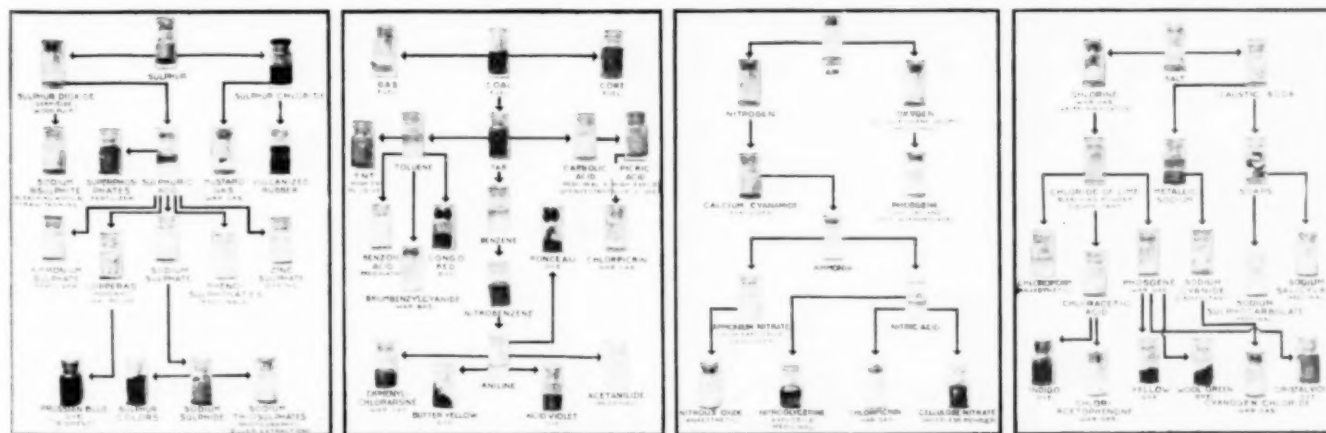
All these features are explained in detail in a booklet which is given to each visitor. The booklet also contains an article by Edwin E. Slosson on "What the Chemist Has Done and May Do in War and Peace." In it he says:

"The Great War forced America into a new industrial field, the manufacture of organic chemicals. When our soldiers met the enemy on the battlefields of France they had to fight fire with fire and poison gas with poison gas. At the same time the home folks found themselves without the dyes and drugs that they had hitherto obtained from Germany. It became necessary then to create

chemical industries of all sorts from optical glass to nitrates and this was done, but with haste and waste, for enterprises which should have been a gradual growth had to be extemporized in a year. But by the time the fighting was over the gigantic task was accomplished and the United States was for the first time 'free and independent' so far as most of the essential chemical products are concerned.

"Now that we have got this chemical industry the question is, What shall we do with it? Shall we again place the weapons needed for self-defense in the hands of possible enemies and shall we once more turn over to our commercial rivals the keys to our most important manufactures?

"The answer to this vital question can only be given by the American people and they will only be qualified to decide when they know the extent and importance of the chemical industry and how it may be kept at home. If now it had been a piece of land that we had acquired through the war, say the little island of Yap, we could have kept it by a few forts and ships. But science is more slippery. It does not stand still but keeps moving—and in the case of chemistry moving very rapidly. The only way to keep it is to keep ahead in it. The American dye maker now has at his disposal all the German patents, but the German chemists have not stopped using their brains and unless we use ours we shall soon be left behind. Of what value was the best patent on a flint-lock the day after the percussion cap was invented? As soon as the Germans found out how to make artificial indigo, the indigo crop of India



FIGS. 2 TO 5 CHART SHOWING WAR AND PEACE TIME USES OF PRODUCTS

From sulphur From coal From air From salt

lost its value. The chemical industry is the offspring of science and dies if weaned from its mother.

"In the model are four groups of buildings looking very much alike because they are much alike, yet, as the labels state, the first may be turning out explosives, the second pharmaceuticals, the third war gases and the fourth dyes. This correlation of the chemical manufactures is a fortunate thing, for it means that while we are developing one of our essential home industries we are at the same time making the most effective provision for national defense. A warship is of no use except for war. But a chemical plant producing dyes may readily turn out explosives in an emergency and the making of medicines must go on in peace time and war time. Young men drilled in the art of presenting arms and forming fours may never have occasion to use this knowledge, but young men trained as chemists may make the most effective combatants as well as the most useful of citizens. The development of American chemical industry is a policy that commands the support of pacifist and militarist as well as of all the rest of us who come somewhere in between.

"The cost of a single battleship, about \$30,000,000, would endow an establishment for chemical research such as the world has never yet seen, and the expense of keeping the battleship in commission, about \$3,000,000 a year, allowing for depreciation, would pay for the education of all the chemists the country could need.

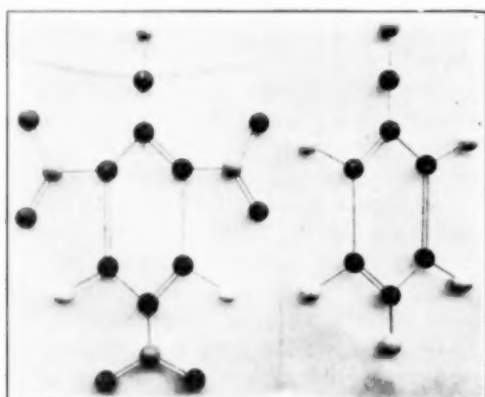


FIG. 6.
Models showing the arrangement of the atoms in the molecules of carbolic acid (right) and picric acid (left). The different atoms in the molecules are represented by different colored balls.

The modern battleship is made as invulnerable as possible but the men on it are not invulnerable. No armor can keep out air and a ship does not have to be sunk if the crew is suffocated. A sharpshooter wastes no more ammunition on a riderless horse. A single airplane with a couple of men may sail over a warship at an unassailable height and besprinkle its decks with a liquid so corrosive that three drops of it touching a man's skin at any part will kill him and so persistent that such little of it as may be caught in crevices will render the ship uninhabitable for days. A 14-in. shell pursues a single course and when it explodes that is the end of it. An ounce of diphenyl-chlor-arsine, an innocent looking white powder, will keep up its bombardment for weeks and its molecular projectiles will fly around corners and into the smallest cracks.

"Armed with such liquids and solids the airman of the next war will not need a machine gun or even bombs to attack the enemy underneath. He does not have to take accurate aim and calculate the allowance for wind,

height and velocity. All he need do is to attach a sprayer to the tail of his machine and rain down poison on the earth beneath as the farmer kills the bugs on his potato field."

It is hoped that this exhibit will enable the public to visualize the importance of chemistry to the nation, that it will show the necessity of building up an adequate Chemical Warfare Service, of developing chemical industries which will make the United States independent of foreign countries, of encouraging basic industrial chemical research and the training of a personnel capable of making this country the most powerful chemically both in war and in peace-time pursuits. The lesson sought to be taught is that any country that hopes to hold its own in peace or war must have an adequate chemical industry guided by scientific research and backed by patriotic public opinion.

United States Crude Oil Production in 1920

The following tables give a brief résumé of the crude oil situation in the United States for the past year:

	INCOME AND OUTGO (Stated in Barrels)			
	Domestic Production	Domestic Consumption	U. S. Imports	U. S. Exports
1920*	443,402,000	437,579,000	106,175,000	8,045,000
1919*	377,719,000	375,559,000	52,822,000	5,924,000
1918	355,927,716	380,242,153	37,735,641	4,900,691
1917	335,315,601	351,569,632	30,162,583	4,098,124

End of Year	STOCKS OF CRUDE OIL			
	Pipeline Stocks	Refinery Stocks*	Field Stocks	Mexican Stocks in U. S.
1920*	133,690,000	21,373,945†	3,423,276‡	7,442,000
1919*	127,867,000	13,143,285	§	2,919,000
1918	121,727,312	15,749,771	7,547,097	.....
1917	146,041,749	11,638,433	13,705,811	.....

* Preliminary figures. † As of Nov. 30, 1920. ‡ East of California. § Figures not available. Note.—Figures for 1920 and 1919 are subject to revision. Figures given are those of the U. S. Geological Survey and the Bureau of Foreign and Domestic Commerce, except in the case of refinery stocks, the source of these being the U. S. Bureau of Mines.

EXPORTS OF CRUDE OIL AND REFINED PRODUCTS FROM THE UNITED STATES, 1917-1920

(Stated in Gallons)

	1920	1919	1918	1917
Crude oil.....	337,886,081	248,821,453	205,829,030	172,121,195
Illuminating oil.....	861,891,942	979,155,147	491,109,815	658,156,487
Lubricating oil.....	410,874,209	274,795,166	257,317,253	280,437,663
Gasoline,naphtha,etc.	642,897,428	372,132,957	559,368,855	415,878,844
Fuel and gas oil.....	846,959,940	584,849,605	1,200,750,319	1,123,473,047
Residuum.....	*	32,999,699	244,474	1,051,113
	3,100,509,600	2,492,754,027	2,714,619,746	2,651,118,349

* Included with fuel and gas oil.

Sugar Imports in 1920

From the reports of the Department of Commerce Lamborn & Co. has compiled a tabular study of the sugar supply during 1919 and 1920. The following summary of the report as published recently in the *Journal of Commerce* shows how the high prices prevailing during 1920 increased the amount of sugar imported from unusual sources.

Normal sources:	Sugar Imports, Tons	
	1920	1919
Cuba.....	2,572,389	2,984,885
Porto Rico.....	368,798	325,175
Hawaii.....	490,906	506,692
Philippines.....	134,721	78,514
Total from normal sources.....	3,566,814	3,895,266
Other sources:		
Far East and Africa.....	380,512	0
South America.....	233,480	15,643
West Indies, exclusive of Cuba and Porto Rico.....	107,993	3,567
Europe.....	53,706	0
Central America.....	43,412	7,633
Canada.....	29,738	0
Mexico.....	27,759	0
Egypt.....	7,438	0
Newfoundland and Labrador.....	54	0
Total from unusual sources.....	884,092	*70,391

* Includes imports from countries which did not send any sugar to the United States during 1920.

Gas Furnaces for Melting Non-Ferrous Metals

BY M. A. COMBS

FOUNDERS, smelters and refiners realize the prime importance of the melting department. The character of the product, casting or ingot, and its cost are directly dependent on the fuel and furnace used. While this realization is general, it is also frequent that a thorough investigation into the various fuels and furnaces to meet the particular requirement has not been made. The great adaptability of gas in the particular furnaces to be used for the various classes of melting is so striking that an exposition will show this fuel to meet every demand most satisfactorily. Gas is often used as the fuel for pit furnaces formerly fired with solid fuel and for all types of open-flame or non-crucible furnaces. Particular advances have recently been made in melting brass aluminum and other alloys in a crucible furnace specially designed for gas fuel and in the gas-fired spherical type of non-crucible furnace. These two furnaces provide a medium for melting all kinds of non-ferrous metals, the choice depending on the scale of the work and character of the metals melted.

NON-CRUCIBLE FURNACE

Oil burning in an open-flame or non-crucible furnace where the flame comes in direct contact with the metal is attendant with excess air and an oxidizing atmosphere. Even with a frequently tilted furnace it does not take much of a metallurgist to know that an oxidizing atmosphere within such a furnace will not produce the best metal. A spherical furnace of this type is ideal, too, for smelters and large foundries. It is a sole question of burning enough fuel in this furnace with a non-oxidizing atmosphere to get the best product. Gas answers this purpose. Its freedom from sulphur is also an advantage over much of the fuel oil now used.

APPLICATION OF THE FUEL

The gas is fed to the furnace at low pressure mixed with just the right amount of air to burn it and no more. After determining the character of the flame and setting the adjustment at the proper relation of gas to air to give a neutral atmosphere within the furnace, the mixture may be controlled by one valve, proportioning the air as the gas is turned up or down. For best practice the burner nozzle is fired on a tangent to the lining of the furnace, well cemented into the furnace or fired to a hole. The pipe containing the mixture of gas and air should be run without reduction up to the nozzle with a minimum bend and rigidly fastened to the tilting furnace from a swing joint on the trunnion of the furnace.

Spherical type of gas-fired tilting furnace is made in various capacities from 500 to 8,000 lb. It is mounted on trunnions at such a height as to give plenty of room for pouring. It is tilted not only for charging and pouring but also during the heat at frequent intervals. The charging door is closed during the heating, the vent being through the pouring hole. The furnace of 1,000-lb. capacity is used with gas as a fuel in foundries for red brass and yellow brass and in smelting with wonderful results.

In making "G" metal a foundry in one of the large

New England shipyards required forty-two minutes per melt of 1,100 lb. of metal, and burned 310 cu.ft. of 600 B.t.u. gas per 100 lb. of metal.

A well-known die-casting company making yellow brass in a spherical furnace makes seven heats in six hours, melting 5,800 lb. with a gas consumption of 269 cu.ft. per 100 lb. Dross amounted to 3.74 per cent.

These figures show for the average of "G" metal and yellow brass a fuel cost of 35c. per 100 lb. of metal melted with gas at \$1.20 per 1,000 cu.ft.

The character of the metal is such as to meet the highest specifications, it is melted economically and with the best of operating conditions as to speed, cleanliness and comfort to the melters. The simplicity is extreme, and the possibilities of this furnace are wide indeed. Its use will decrease lost motion in foundry practice. It simplifies the production problem at the start and from the melting on speeds up and simplifies casting and ingoting.

Discussion of general foundry practice may not belong to the consideration of gas as the fuel; however, the fuel is the controlling element in the furnace and the melting unit profoundly affects the subsequent foundry operations. The potentialities of the large gas furnace to improve foundry practice, from the melting unit on, are evidently worth thinking about.

GAS VERSUS ELECTRICITY OR OIL

In comparing gas against electricity for melting furnaces the most striking advantage of gas after its economy is the flexibility of the furnace. Any alloy may be melted in a gas furnace without changes, excepting rarely a relining in the non-crucible type—no changes at all are necessary in the crucible type. This is true no matter whether a high lead, high zinc or any other difficult composition of copper or aluminum alloy is melted. There are some alloys which it is no easy matter to charge into an electric furnace, and some copper alloys which probably cannot be so melted.

Oil at present is equal to if not more expensive than gas in fuel cost alone. When the cost of oil was more favorable, the factors which even then gave gas an advantage were cost of storage, cost of preparation, crucible or lining life and metal shrinkage. These facts will be further brought out in comparative figures. However, there are certain advantages of the use of gas that do not appear in using any other fuel. Gas does not need to be stored, an economy of space and overhead, and it is not paid for until used, a further saving on investment. Due allowance should be given for these facts when considering the fuel question.

GAS CRUCIBLE FURNACE

The crucible pit furnace fired with coal or coke has long been the melting unit in non-ferrous foundries large and small. In many cases, particularly in the small foundry, it is still desirable to use a crucible furnace. However, pit furnaces with solid fuels are certainly not the speediest method of melting metal, even if they have done much good work in the past. Their continued existence is not justified merely as survivors of the days when metal founding was a black art. In economy of space alone a battery of gas-fired crucible furnaces takes only one-third the room needed for the solid-fuel furnace, a figure that does not include saving of space needed to store fuel. Two to three heats per furnace is the average of the pit fire as against eight heats per day with gas. For this class of melt-



FIG. 1. A BATTERY OF GAS CRUCIBLE FURNACES
FLUE-CONNECTED

ing one of the most important advantages to credit to gas is that it is not necessary to have the furnace started in the early morning hours in order to pour the first heat when the molders are ready for the metal. The first heat can be taken out of the gas furnace in about an hour, which means that the melters do not have to start work any earlier than the molders. When figuring in the attendant costs of other fuels, such as labor, time and shrinkage, and allowing for storage and preparation, the result shows that while the cost per B.t.u. in the case of gas is naturally higher, the cost per pound of metal melted, or the unit production cost, is lower.

DESIGN OF FURNACE AND APPLICATION OF FUEL

The properly designed crucible furnace for gas fuel is a cylindrical furnace with an interior diameter just large enough to admit the tongs, when removing the crucible. The crucible is set on a block at such height that the top of the crucible is not more than 2 in. below the furnace cover. The crucible block is graded toward a slag hole so that splash metal will not collect in bottom of furnace.

In firing a crucible furnace with gas, the fuel should be fed to the furnace mixed with the proper amount of air for perfect combustion, this mixture being controlled by one valve. A burner nozzle directing a fire tangent to the lining of the furnace at the bottom of the crucible gives the best distribution of heat and prevents localized heating of the pot. This method of firing is most effectually done by firing to a hole, the furnace being so designed that the amount of back pressure prevents sucking in secondary air around the nozzle. The advantage of firing to a hole against imbedding the nozzle in the refractory wall is that it prevents burned nozzles and the necessary care in cementing them in.

The ordinary type of furnace has a flat refractory cover with a central hole for charging metal into the pot and as a vent for the products of combustion. The fumes from the metal escape through this hole and it is necessary to have a hood to take the fumes out of the room. In melting red brass this is not so necessary, as the fumes are not as objectionable and harmful as those of yellow brass, or a copper:lead alloy.

From the last two alloys a gas furnace may be

COMPARATIVE FIGURES FOR CRUCIBLE MELTING

Fuel cost:		
75 lb. of coal per 100 lb. of metal at \$16 per ton.....		\$0.60
2½ gal. of oil per 100 lb. of metal at 16c. per gal.....		.40
500 cu.ft. of gas per 100 lb. of metal at \$1.20 per thousand.....		.60
Crucible costs. No. 80 crucible at \$8:		
Coal 15 heats.....	266	
Oil 20 heats.....	21	
Gas, 25 heats.....	16	
Shrinkage:		
Coal, 3½ per cent at 30c. per lb.....	1.05	
Oil 3 per cent at 30c. per lb.....	.90	
Gas, 2½ per cent at 30c. per lb.....	.75	
Labor:		
Coal, 2 hours at 70c. per hour.....	1.40	
Oil, 1 hour at 70c. per hour.....	.70	
Gas, 1 hour at 70c. per hour.....	.70	

Summary of total costs per 100 lbs. of metal melted:

	Coal	Oil	Gas
Fuel.....	\$0.60	\$0.40	\$0.60
Crucible.....	266	21	16
Shrink.....	1.05	.90	.75
Labor.....	1.40	.70	.70
	\$3.316	\$2.21	\$2.21

specially designed with a hood incorporated in the cover. This furnace cover is flue-connected, the fumes passing directly into the pit flue and out by an overhead flue. This type of cover also acts as a preheater in that the charge for the crucible may be placed in it and the products of combustion passing through it to the flue preheat the charge, effecting greater economy in fuel. A battery of six of these furnaces is shown in Fig. 1. They each hold a No. 80 crucible which has a capacity of 300 lb. of 50 per cent copper and 50 per cent lead.

OPERATING FIGURES—GAS CRUCIBLE FURNACE

Two furnaces, similar to the ones shown in the illustration, melting 50-50 copper and lead alloy in a foundry in the metropolitan district, show a fuel consumption of 400 cu.ft. of gas per 100 lb. of metal. This foundry also melts aluminum in the same furnaces.

A foundry in New England using four of these furnaces with No. 80 crucibles runs five heats of brass and eight heats of aluminum per furnace per day with a gas consumption of 6,700 cu.ft. per furnace per day. Thus 1,000 lb. of brass, or 1,000 lb. of aluminum, may be melted at a fuel cost of \$8.71 with gas at \$1.30 per 1,000 cu.ft. In this foundry one crucible has been used over fifty heats, a particularly long life for a crucible, even in a gas furnace. The shrinkage on the brass is only 2 per cent, a figure which is, however, not exceptional in gas crucible furnaces.

The accompanying table shows a day's run in a foundry in New York City melting 85-5-5 brass.

DAY'S RUN, NO. 40 CRUCIBLE FURNACE					
No. Heat	Time Started	Time Finished	Time per Heat, Minutes	Lb. Metal Melted	Cu.Ft. Gas per Heat
1	8:40	9:30	50	105	500
2	9:40	10:21	41	105	375
3	10:30	11:10	40	105	320
4	11:19	11:49	40	105	280
5	12:00	12:30	30	105	300
6	12:40	1:12	32	105	280
7	1:24	1:56	32	105	250
8	2:05	2:33	28	105	300
Totals.....			293	840	2,605

Average time per melt, $293 \div 8 = 35$ minutes.

Gas consumption, 310 cu.ft. per 100 lb. of metal melted.

Another foundry reports the following figures in brass melting: Metal melted, 848 lb.; gas consumption, 3,026 cu.ft.; metal loss (shrinkage), 2.25 per cent; fuel cost, 350 cu.ft. per 100 lb. gas at \$1 per 1,000 cu.ft., or 35c. per 100 lb.

Since the final cost per unit of production is less with gas than any other fuel, it is the most economical fuel.

Investigations of the Chemical Literature—III

Patent Searches—Facilities for Investigation Offered by the Patent Office—Official Publications Relating to Patents—Obtaining Copies of United States and Foreign Patents—Importance of Providing Better Facilities for Training in the Use of Chemical Literature*

By FRANK E. BARROWS

Patents

PATENTS, from their very nature, require consideration from various aspects other than as a part of the chemical literature. Thus the patentability of inventions, the filing and prosecution of applications for patents, the construction, validity and scope of issued patents, questions of infringement of unexpired patents, patent litigation, property rights in patents, the rights and obligations of patentees, etc., are matters primarily involving patents as patents rather than as publications, and are matters requiring consideration from the standpoint of the relevant principles of the patent law applicable thereto, as well as from the standpoint of the chemical principles that are involved.

Patent searches or investigations may thus be of a special character. In considering questions of infringement, for example, the primary search extends only through the United States patents granted during the last seventeen years (the term of a United States patent), and requires consideration of the invention claimed rather than, or in addition to, the invention described, but inasmuch as the claims of a patent may require to be construed by the accompanying description and in the light of the Patent Office proceedings leading up to the grant of the patent, as well as in view of the prior state of the art disclosed by prior patents and publications, and in accordance with relevant principles of the patent law, a more extended search to include expired United States patents and other patents and publications may be important or even essential.

Investigations of the patentability of inventions, such as are made to determine the advisability of making application for patent, or by the Patent Office examiners in determining the patentability of inventions set forth in patent applications, as well as investigations of the scope and validity of issued patents, may likewise require an extended search of the prior patents and publications, to determine whether the invention is new and whether it is a patentable invention or discovery, within the meaning of the patent law.

Patent investigations thus include both investigations of patents as patents, and investigations or searches of patents as publications and as a part of the chemical literature.

THE PATENT LITERATURE

Considered as a part of the chemical literature, the patent literature furnishes one of the most important fields of search, inasmuch as it records the inventions and improvements, and hence the progress, made in almost all fields of chemical industry. Not infrequently inventors have patented their inventions without having published any descriptions of them elsewhere and with-

out any abstracts or digests of their inventions appearing in the periodical literature. The patent literature therefore contains much that is not available elsewhere.

UNITED STATES PATENTS

More than 1,300,000 United States patents have been granted, of which a very considerable number relate to chemistry and allied subjects. A proper classification of these patents is therefore indispensable for search purposes. The classified patents, however, are available only at the Patent Office at Washington, and for this reason comprehensive searches through the various classes of United States patents can be satisfactorily made only in Washington.

The classification of United States patents, so far as it is official, is set forth in the "Manual of Classification"; in the "Definitions of Revised Classes and Subclasses," and in the "Classification Bulletins" which are issued semi-annually by the Patent Office.

The "Manual of Classification" gives instructions for searching the classified United States patents, together with a list of classes and subclasses and an index of class and subclass titles. It is in constant use by those making searches at the Patent Office. Copies of this manual may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 50c.

The work of classifying U. S. patents, of which there are about three hundred separate classes and thousands of subclasses, has been largely conducted by the classification division of the Patent Office. A history of this division and of its work and methods of classification is given in the "Report of the Investigation of the United States Patent Office," made by the President's Commission on Economy and Efficiency (published in 1912 as H.R. Document 1110, Sixty-third Congress, Third Session). A short description of the Scientific Library of the Patent Office and of the search room, as well as of the card index of Chemical Literature, is also given in this report (Appendix K).

The difficulties in making a satisfactory classification of patents for search purposes is complicated by the different kinds of patent searches required—whether novelty, validity or infringement—and this difficulty is well recognized by the Patent Office. There has been at times an unfortunate tendency in the classification of chemical and related patents to disregard the prevailing classification of the other chemical literature, and to use unusual terms and make unusual lines of distinction, which the average chemist does not readily recognize and which may even give trouble to the experienced patent searcher.

OFFICIAL CLASSES AVAILABLE AT PATENT OFFICE

As is to be expected, the chemical patents are classified in more or less definite and distinct classes, and

*For Parts I and II see CHEM & MET. ENG., vol. 24, Nos. 10 and 11, pp. 423 and 477, March 9 and 16, 1921.

are segregated, for purposes of examination, in a few examining divisions. The official classes of patents are accessible in the public search room of the Patent Office. Duplicate sets of classified patents are provided in the examining divisions. Many of the chemical classes of patents have never been officially reclassified, and the present official classification is often unsatisfactory for search purposes. Some of these classes have, however, been in part unofficially reclassified by the examiners who have examined them, so that a more satisfactory classification will be found in the examining divisions. It is thus quite common for different examiners to have special subclasses or digests of patents, both United States and foreign, as well as of other publications, along the lines which they have occasion to search. Some of these unofficial classes and digests are of very great value, but unfortunately they are not accessible except in the examining divisions, and with the permission of the examiners.

OTHER FACILITIES OFFERED BY PATENT OFFICE

In making searches at the Patent Office at Washington, not only does the searcher have available the classified United States patents, but he has access to the files of such patents containing the various Patent Office proceedings leading up to their grant, including the original application papers and amendments thereto, and the official communications of the examiners who examined the application, in which are referred to the prior patents and publications which the examiners found upon their search and considered relevant to the invention sought to be patented. By examining the files of United States patents which are of nearest subject matter to the investigation in question, it may be possible to obtain reference to prior patents or publications which are of particular interest and which would not be readily available otherwise.

A further value of the patented files is the indication therein of the classification of the respective patents and the indication in the various official actions of the classification of the prior patents which are referred to therein. Attention may thus be directed not only to prior patents of relevant subject matter, but even to other classes of the Patent Office which might otherwise have been overlooked but which may contain patents of interest. The number of classes and subclasses of patents is so great and the classification of patents is in many instances so complex that relevant classes or subclasses may well be overlooked unless special precautions are taken to insure their proper consideration.

Likewise available at the Patent Office are the records of interference proceedings in which issued patents have been involved—records which in some cases contain lists of prior patents and publications relating to the same subject matter as the patent, in others testimony of interest in connection with the patented invention.

COURT RECORDS OF PATENT CASES

Valuable information may likewise be obtained from many of the court records of patent cases and even from the court decisions in such cases, inasmuch as a consideration of the question of patentability, in view of prior patents and publications, is almost always raised in such cases. Extended searches are usually made in connection with such litigation and the pertinent results thereof made a part of the record of the case. The testimony forming a part of court records may likewise contain valuable information.

Attempts to make comprehensive investigations of United States patents elsewhere than at the Patent Office are generally unsatisfactory. However, abstracts of United States patents, as well as foreign patents, are published in *Chemical Abstracts*, classified in the same way as the other literature and similarly indexed, and a search through this field is a useful check upon any search made at the Patent Office itself. Nevertheless, experience has shown that a search through *Chemical Abstracts*, even during recent years, cannot be relied upon to disclose all patents of interest along any particular line, and, of course, the *Abstracts* go back only to 1907.

PARTIAL LISTS OF CHEMICAL PATENTS

There has been no comprehensive list published of United States patents relating to chemistry.

A valuable digest of the older United States patents relating to chemical industry has been published in *Census Bulletin 210* (pub. 1902), but this list includes only patents granted prior to 1902, and hence only expired patents. Although the bulletin is now out of print, this list was also published as an appendix to *Census Reports, Vol. X, Twelfth Census of the United States, Manufactures, Part IV, Special Reports on Selected Industries*.

One of the few partial lists of United States patents that have been published appears in a German publication—viz., in vol. 3 of Winther's "*Patente der organischen Chemie*" (pub. 1910). This list includes patents relating to organic chemistry granted between 1895 and 1908, with the number, date, patentee and title of the patent, and the number of the corresponding German patent, if any.

Another of the partial lists of United States patents published is that of patents granted to Germans and Austrians, compiled by the Federal Trade Commission as *prima facie* enemy-owned patents. This list, or the part of it of more particular relation to chemistry, has been published by the *Oil, Paint and Drug Reporter* during the past year, and also appears in the "1918 Year Book" of that periodical.

A similar list of formerly enemy-owned patents, which have been taken over by the Alien Property Custodian and transferred to the Chemical Foundation, is contained in a "Temporary List" issued by the Chemical Foundation. This list includes about four thousand patents now in force, that is, granted during the past seventeen years.

All of these lists are at best but partial and incomplete, and unsatisfactory from the standpoint of making any comprehensive search.

BRITISH PATENTS

British patents have been granted since 1617, and as early as 1622 we find patents relating to chemical subjects—viz., the manufacture of soap and of white and red lead pigments. Prior to the year 1700, patents were also granted relating to various other chemical subjects, including alum, salt, pottery, the parting of silver from lead, saltpeter and various metallurgical processes.

The British patents are more generally accessible for purposes of search than the patents of any other country, for the reason that the British Patent Office has published classified abstracts or abridgments of all the patents which have been granted since the earliest days of the British patent system and up to within the last

digests or abridgments of British patents granted between 1622 and 1866 relating to "acids, alkalis, oxides and salts"; another volume containing digests or abridgments of British patents granted between 1617 and 1866 relating to "oils, fats, lubricants, candles and soaps," and so on.

Between the years 1855 and 1908 the classified British patents of each class have been published in nine successive volumes, each covering a period of a few years, so that, for example, the nine volumes of the class relating to "acids, alkalis, oxides and salts, inorganic," will contain abstracts or abridgments of the British patents of this class granted during this period. A similar series of nine volumes contains abstracts or abridgments relating to organic chemistry, and the same is true of metallurgy and other various classes into which the British patents are officially classified. The classified abridgments since 1908 are being published a few pages at a time.

In addition, fifty-year subject-matter indexes of the classified British patents have been published for each class, covering the period from 1861 to 1910.

GERMAN PATENTS

A complete set of German patents is available at the Patent Office in Washington, and in addition, a classified set of German patents for recent years, classified according to the German classification. A search of German patents can accordingly be much more readily conducted at Washington than elsewhere.

However, many of the German patents are abstracted in the German abstract and review periodicals, and in addition many compilations of German patents, relating to different subjects, have been published. Notable among these is the work by Friedlaender, relating to dyestuffs. This work, which has been issued in twelve parts and which covers the period from 1877 to 1916, gives a very complete and classified review of the German patent literature relating to organic dyestuffs.

A similar work is the three-volume compilation by Winther, "Patente der Organischen Chemie." This work is not so well known as Friedlaender's, but it is in some respects more accessible for search purposes. The first volume contains abstracts or digests of the German patents and applications between 1877 and 1905, relating to organic compounds other than dyestuffs. These are classified according to subject matter—for example, hydrocarbons, alcohols, ketones, alkalis, photographic developers, etc.

Vol. 2 contains abstracts or digests of German patents relating to organic dyestuffs within the same period, 1877 to 1905, and these patents are classified according to classes—for example, sulphur dyes, indigo dyes, azo dyes, etc.

The third volume, published in 1910, is the index volume, and contains several different indexes, including a numerical list of German patents relating to organic chemistry, with the corresponding United States, English, French, Austrian and Russian patents, if any; also a list of United States patents (organic chemistry) between 1895 and 1908 with the number, date, patentee and title of the invention and the corresponding German patents, if any. Similar lists are given of the British, French, Austrian and Russian patents, with the corresponding German patents, if any. The volume also contains a list of patentees, with the patents of each patentee and of each company classified by subjects. The volume includes finally a subject-matter

index of the various organic compounds, intermediates, etc., with reference to the volume and page of the first two volumes of the work where they will be described.

A useful list of trade names of chemical compositions and products of various kinds is also included in this same volume (Winther, vol. 3), with indication of the chemical composition, manufacturer, and the patent or literature citation where a description of the substance will be found.

OTHER FOREIGN PATENTS

The patents of some of the other foreign countries, including France, Austria, Switzerland, Denmark, Norway and Sweden, are likewise available, in classified and bound form, at the Patent Office library, and for this reason are more readily searched there than elsewhere.

In addition to the foreign patents available at the Patent Office library, duplicate sets of patents of several foreign countries are accessible to the examiners in the examining divisions, classified the same as the United States patents, but may be there examined only with the examiner's permission.

The patents of some foreign countries are not available even at the Patent Office, particularly of those countries which do not publish their patents. Copies of such patents are usually obtainable only in manuscript form from the patent offices of these respective countries. Information regarding such patents may, however, be obtainable through the official Patent Office publications of each country. Thus, Canadian patents are not published, but certain of the patent claims are published in the *Patent Office Record*.

Frequently the same invention will be found patented in several different countries, and will be found abstracted or reviewed in the current literature. Again, the inventor may publish a full account of his work in addition to the particular part which he patents. Accordingly, when a patent is discovered which is of particular interest, it is sometimes profitable to see whether the same inventor has taken out patents in other countries, or has published other descriptions of his work at about the same time, from which still further information is obtainable.

If reference is found to foreign patents which were not published, or which are not available, it may nevertheless be possible to find a corresponding patent granted in another country, if there is any, or find further information about the particular patent or invention from the contemporaneous periodical literature.

OFFICIAL PUBLICATIONS RELATING TO PATENTS

United States. The official publication of the United States Patent Office is the *Official Gazette*, issued weekly. It contains an abstract of all patents granted each week, giving the title of the invention, the name of the inventor, the assignee if any, the date of filing and serial number of the application for patent, the classification of the patent (according to the Patent Office classification), one or more typical claims of the patent, and an illustrative figure of the drawings if the patent is accompanied by drawings. It also includes an index of patentees and of inventions, and a classified list of the patents, classified according to the Patent Office classification. The subscription is \$5 a year from the Superintendent of Documents, Government Printing Office, Washington.

Yearly indexes of United States patents and patentees

(including assignees) are also published under the title "Annual Report of the Commissioner of Patents." These annual indexes, during the last few years, also contain a classified list of the patents according to the Patent Office classification. These annual indexes are also obtainable from the Superintendent of Documents (price \$1).

Canada. The official publication of the Canadian Patent Office is the *Canadian Patent Office Record*. It is similar to the *Official Gazette* of the United States Patent Office. The annual subscription rate is \$4 from the Commissioner of Patents, Ottawa.

Great Britain. The official publication of the British Patent Office is the *Illustrated Official Journal*. It is published weekly and contains illustrated abstracts of all British patents, as well as indexes of applications filed and patents granted. This publication is obtainable from the Patent Office, London (subscription rate £3).

Germany. The official publication of the German Patent Office is the *Patentblatt*, published weekly, with a supplement *Auszüge aus den Patentschriften*, containing illustrated abstracts of German patents.

SUBSCRIPTIONS TO UNITED STATES PATENTS

By making a deposit with the Patent Office, it is possible to subscribe for one or more classes or sub-classes of United States patents and to obtain from week to week copies of the patents that are granted in such classes or sub-classes. In order to obtain patents relating to any particular subject, it is necessary to subscribe to such classes or sub-classes as contain patents relating thereto. It is not possible, for example, to subscribe for "all chemical patents," or all patents relating to the production of a particular chemical substance, but it is necessary to subscribe for specific classes or sub-classes according to the Patent Office classification. Subscriptions of this kind, therefore, may include many patents that are not of interest to the subscriber but which happen to be classified by the Patent Office in the same classes or sub-classes as patents in which he is interested. The minimum deposit required to enter a subscription is \$5. Inasmuch as the cost of patents is 10c. each, it is evident that the cost of the subscription, and the period of time which a given deposit will cover, will vary with the number of patents issued in the particular classes or sub-classes subscribed for. The deposit must, of course, be replenished from time to time to maintain the subscription in force.

OBTAINING COPIES OF UNITED STATES PATENTS

Copies of United States patents can be obtained from the Patent Office at Washington for 10c. each. For convenience in ordering patents and in remitting therefor, the Patent Office sells coupons, specially printed for the purpose, in books of one hundred coupons for \$10 and pads of twenty coupons for \$2. The use of these coupons requires merely the filling in on the coupon of the data of the patent and the address to which the patent is to be sent, and the forwarding of the coupon to the Patent Office. For ordering small numbers of patents from time to time the use of coupons is usually more satisfactory than the making of separate remittances with each order.

It not infrequently happens that United States patents cannot be obtained in printed form from the Patent Office, owing to the temporary exhaustion of the supply. Photographic copies of such patents can, however, be

obtained, either from the Patent Office or from some library that has copies of the patents and facilities for photographic reproduction.

OBTAINING COPIES OF FOREIGN PATENTS

While copies of foreign patents can be obtained by sending to the respective countries for them, this involves a considerable delay. A more expeditious way of obtaining copies of such patents is by ordering photostatic copies from the Patent Office at Washington, or from such libraries as contain them and have facilities for photographic reproduction. The patents of most foreign countries, in so far as such patents have been published, are available at the Patent Office at Washington, and photostatic copies of any such patents can be obtained. The cost of obtaining patents in this way depends upon the number of pages of the specification and the number of sheets of drawings. The charge by the Patent Office is 15c. a page for single pages and 25c. a page for double pages. An estimate of the cost of any particular patent or patents can be obtained from the Patent Office in advance of ordering them. By making a deposit with the Patent Office of \$25, with replenishment of the deposit as it becomes exhausted, such copies of foreign patents can be ordered and charged against the deposit account. Photostatic copies of United States patents (where the printed copies are exhausted) as well as of other publications in the Patent Office library can similarly be ordered and their cost charged against such a deposit.

The patents of some foreign countries are not published, and these patents are usually obtainable only in manuscript form, or in the form of photographic copies, from the Patent Office of the country in which they are granted. Canadian patents (which are not published) can thus be obtained from the Patent Office at Ottawa. Estimates of the cost of such patents will be furnished by the Canadian Patent Office upon request.

Where any large number of foreign patents are desired, and the delay of a few weeks in obtaining them is not of particular importance, they can usually be obtained at less expense by ordering them directly from the country of their origin.

OBTAINING COPIES OF PERIODICALS AND OTHER PUBLICATIONS

The obtaining of copies of articles appearing in periodicals and other publications has been very materially facilitated by the photographic processes of reproduction which have been installed in many of the leading libraries. These facilities are of special importance to investigators of the chemical literature, whose investigations frequently lead them to periodicals and other publications that are available only at certain libraries. They are also a great convenience in enabling the investigator to obtain copies of separate pages, or of articles from different periodicals, etc., in a form convenient for future reference and consideration. The cost of obtaining photographic copies varies somewhat with different libraries, but is usually around 15c. to 25c. a page.

Among the libraries which thus furnish photostatic or photographic reproductions of periodicals and other publications are the Patent Office library at Washington, the John Crerar Library of Chicago, the Carnegie Library of Pittsburgh, and the Engineering Societies, Chemists' Club and Public Libraries of New York City.

IMPORTANCE OF PROVIDING BETTER FACILITIES FOR INVESTIGATING AND USING THE CHEMICAL LITERATURE

The importance of providing better facilities for making use of the chemical literature is well set forth in the following extract from the "Report of the Committee on Publication of Compendia of Chemical Literature, etc.," appearing in the *Journal of Industrial and Engineering Chemistry* for May, 1919, pages 415-417:

The committee recommends cordial and effective co-operation in suitable ways by the American Chemical Society and other American scientific and technological bodies with the efforts of the chemists of Great Britain to organize the work of publication in English of compendia of chemical literature and to encourage the production of chemical literature in English.

In presenting the whole problem of the organization of compendia, monographs, etc., in English by the British as well as by ourselves, the committee would urge that the question be considered from the point of view of national (cultural) importance as well as from that of scientific utility. The almost exclusive use of German compendia and monographs in all countries has given the German scientists an influence in foreign countries (from China to Argentina, Spain and Russia, and all lands between these countries) entirely out of proportion to their real share in scientific productiveness—leading to the migration of foreigners to Germany for their advanced studies, with resultant serious influences, political, commercial and cultural, in these countries. We must recall, too, that in their compendia and monographs, German chemists have been wont to ignore to a certain large extent, or to underrate, the work done in other countries, especially perhaps that done in the United States.

The compilation of compendia of chemical literature requires extensive investigation of the literature by the compilers. The production of monographs of value likewise requires investigation of the literature by the producers. Such investigations necessarily involve the use of library facilities, and must be made by investigators trained and experienced in making such investigations. Accordingly, if the compilation of compendia and the production of chemical literature in English are to become at all general, and if proper use and investigations of the literature are to be made in connection therewith, and by chemists generally in the practice of their profession, it is important for future American chemists to be trained properly in the use of the chemical literature and in the facilities for its investigation.

TRAINING IN THE USE OF CHEMICAL LITERATURE

Adequate training in the use of the chemical literature is not as general as it should be, nor does its importance seem to be generally recognized. The proper use and investigation of the chemical literature necessarily involves the use of library facilities and familiarity therewith, yet until recently we find no text-book or manual dealing with the subject comparable to the many laboratory manuals which deal with the use of laboratory facilities.

A discussion of the extent to which training in the use of chemical literature is given in a number of American technical schools and universities is given in an excellent paper on "Chemical Literature and Its Use," by Miss Marion E. Sparks of the University of Illinois, appearing in *Science* for April 19, 1918, pages 377-381. In this paper Miss Sparks also describes the Journal-Library Course given to students in the chemical and chemical engineering courses at the University of Illinois. This paper is much less complete, however, than the lecture notes used in the course, which outline the entire subject in a comprehensive manner. These lec-

ture notes were published by Miss Sparks in pamphlet form in 1919. The first edition is already exhausted but a second edition will probably be published during the present year.

There is likewise need of a more general appreciation, among American chemists and among American colleges, technical schools and universities, of the importance of proper use of the chemical literature, and of more general training in its use. "Library" courses, as well as "laboratory" courses, should be included in every college and university course in chemistry and chemical engineering.

Legal Notes

BY WELLINGTON GUSTIN

Process for Making Arsenate of Lead Is Held Valid—Growth of the Industry

In a suit on the Luther and Volck patent, No. 892,603, for a process for making arsenate of lead, the Circuit Court of Appeals of the United States has affirmed the lower courts' decision holding the patent not void for lack of invention. The California Spray Chemical Co. charged infringement of the process by the Toledo Rex Spray Co.

The process is carried out by combining lead oxide (litharge) suspended in water and arsenic acid in solution; the reaction being assisted by the cyclic action of the catalyzing agent—either acetic acid or nitric acid. The specification gives the formula or combining weights of lead oxide and arsenic acid, respectively, as varying from 1.938 to 2.9 parts of the lead oxide to one part of arsenic acid, according as ortho-arsenate or pyro-arsenate is desired. As shown by the specification, the weaker acid solution produces the ortho-arsenate, "with traces of pyro-arsenate of lead, lead salts of the catalyzer, and the catalyzer." The stronger acid solution (practically two parts of lead oxide and one part of arsenic acid) produces pyro-arsenate, "with traces of ortho-arsenate of lead, lead salts of the catalyzer, and the catalyzer." A varying of these proportions produces a corresponding variation in the acidity of the product. The preferable proportion of the catalyzing agent is given as "1 to 3 lb. of the catalyzer to 100 lb. of the lead oxide."

DEFENSE OF LACK OF INVENTION AND INSUFFICIENT DISCLOSURE

The defenses were that the patent was invalid and there was no infringement. It was contended that in view of the prior art there was lack of invention, especially if the patent was construed broadly enough to include defendant's process, and that the patent did not sufficiently disclose its process.

Regarding invention it was said that standard chemical authorities had taught that arsenate of lead could be obtained by the action of arsenic acid or nitrate of lead, by direct precipitation. Previous to the patent in suit the commercial method of making arsenate of lead was by combining either acetate of lead or nitrate of lead with arsenate of soda; the products of the respective reactions consisting of arsenate of lead, together with acetate or nitrate of soda, according as acetate or nitrate of lead was used. In neither the

general teaching nor the double decomposition process was there any catalytic or cyclic action involved.

However, back in 1866, Bell and Fell had been granted a patent, No. 59,901, for an improvement in the manufacture of white lead, by which sulphate of lead was produced by the direct action of nitric acid upon lead oxide (forming nitrate of lead), to which product was added sulphuric acid and water, resulting in a lead sulphate. In this process the nitric acid acted as a catalyst or agent in liberating, from time to time, portions of the oxide of lead and converting the same into lead nitrate, which, by the action of the sulphuric acid, are immediately converted into lead sulphate, the constant repetition of this process until the whole mass of lead oxide is converted into lead sulphate constituting the so-called cyclic action. The patent also states that acetic acid may be used in place of nitric acid.

QUESTION OF INVENTION CONSIDERED

Therefore, the court said the presence or absence of invention in the patent in suit depended on whether at the time of Luther and Volck's application in 1907 it was within the expected skill of the chemist, knowing first that lead nitrate would react with arsenic acid to produce lead arsenate, and second that the Bell and Fell process converted lead oxide into sulphate of lead by the use of nitric acid as a catalyzer, to know further that arsenate of lead could be produced instead of sulphate by substituting arsenic acid for Bell and Fell's sulphuric acid. On these facts it would seem the presence of invention in the Luther and Volck patent was doubtful, says the court.

Arsenate of lead in combination with other substances has long been used in the paint and dye arts, but uncombined its sole use seems to have been as an insecticide. The insecticide art, however, involves not only chemistry but entomology, the live problem being to obtain a product such as will cover the foliage and fruit, and so result in killing the insect without killing or injuring either fruit or foliage. Climatic conditions and the degree of sensitiveness of both fruit and foliage are necessarily involved. The invention of the patent in suit came from a campaign for the extermination of the codling moth in California, conducted by the University of California.

A factory was established at Watsonville, Cal., for the manufacture upon a large scale of arsenate of lead in accordance with the formula of the patent. The process is shown to have substantial advantages over the process of the prior art, its new and especially distinguishing feature being the ability to control more positively and more readily the character of the arsenate (whether ortho or pyro), including the percentage of acidity. Evidence showed the process more readily and effectively produces superiority of product as respects smoothness, distribution and adhesiveness. The double decomposition process has been largely superseded by the process of the patent.

Beginning in March, 1916, licenses under the patent were issued to the two largest chemical corporations, perhaps the largest drug manufacturer, the largest dry color manufacturer, one of the largest paint manufacturers and one of the largest insecticide manufacturers in the United States—all except one operating upon substantial royalties, the remaining company paying an outright consideration of \$30,000, besides royalties.

It was said that while it may seem that it would naturally have occurred to one acquainted with the

Bell and Fell disclosure to try the substitution of arsenic acid for sulphuric acid in making arsenate of lead, the fact remains that in the forty years which elapsed no one tried that experiment. In the light of that fact and the further fact that mere analogy is not, in chemistry, usually so certain an index as in mechanics, the court could not say that it was within the expected skill of the chemist to know that Bell and Fell's process of making sulphate of lead was equally available for producing arsenate of lead by the mere substitution of arsenic acid for sulphuric acid. Further, the court said that the favorable public reception and commercial success of the process in suit removed whatever doubt might otherwise exist as to invention.

DISCLOSURE SUFFICIENT, DECLARES THE COURT

On the question of lack of sufficient disclosure in the patent to enable one skilled in the art to practice it, the court held that it was sufficient to enable one skilled in chemistry to practice the process; though conditions of temperature, quality of the ingredients used and perhaps other elements require care and to some extent experimentation to produce the best results (*Minerals Separation, Ltd., vs. Hyde*, 37 Sup. Ct., 82).

As the patent was construed it was found that defendant's process infringed it. It employed 2.2 parts of lead oxide to one part of arsenic acid, being thus between the minimum and maximum of the patent, and it employed 2.81 per cent of nitric acid as a catalyzer, which is between the minimum of 1 and the maximum of 3 per cent specified in the patent. The court said it was not important that defendant makes only a pyro-arsenate, or that plaintiff uses the word "ortho" as a trade mark, making its ortho-arsenate product more prominent than its pyro-arsenate. Use of the formula of the patent was enough to charge defendant.

Where Customs and Usages Were Part of Contract—Deliveries Explained by Showing Custom

Customs and usages implied in a contract came up in a Georgia case in which the Producers' Co. sued the Empire Cotton Oil Co. alleging breach of two written contracts for the sale of peanut products. Under terms of one of the contracts the products were to be delivered in March, 1918; under the other, delivery was to be made in April, 1918. The plaintiff alleged that both contracts were breached by the Empire company in failing to deliver on demand in July, 1918, and sued for damages accordingly.

It was alleged that there was a custom of usage of the trade among dealers in peanut products to the effect that when, under a contract of sale, such products were to be shipped during a named month in the year, and delivery was not demanded by the purchaser during that month, and there was likewise no tender of delivery by the seller, the time of delivery was automatically extended from month to month until either the purchaser made demand upon the seller for delivery or the seller tendered delivery to the purchaser.

The Court of Appeals reversed judgment in favor of the plaintiff. It said while the terms of a written contract cannot be varied by a contemporaneous oral agreement, yet it is permissible to show the existence of a custom of the trade or business, not at variance with such terms, concerning which the contract was made, which is of such universal practice as to justify the conclusion that the custom became a part of the contract.

Effects of Metallic Structure Upon Properties

The Disposition, Amount and Nature of the Various Constituents of a Metallic Alloy Have a Great Effect Upon the Mechanical Properties of the Substance and Its Resistance to Corrosion, Especially in Strong Electrolytes

BY HENRY S. RAWDON
Physicist, Bureau of Standards

THE ultimate aim of any metallographic examination is to show in what manner and to what extent the characteristics of the material, particularly the mechanical properties, are dependent upon the particular features characterizing the structure of the metal under observation. To discuss this phase of the subject, even in a manner only approximately complete, is manifestly impossible in small limits. Only a few of the most obvious effects of structure upon the properties will be mentioned.

MECHANICAL PROPERTIES AS AFFECTED BY STRUCTURE

It must be borne in mind in a discussion of this subject that the mechanical properties of any material, as expressed numerically, are more or less dependent upon the method of determination used—for example, size and shape of test specimen, rate at which the stress is applied, etc. The structural features of the material are closely related to the mechanical properties, this relationship of course being much more apparent in the case of the grosser or macroscopic features than for the very minute characteristics, as will be evident in the following examples which are discussed. The previous treatment, mechanical as well as thermal, also affects the mechanical properties, although in this case it may be contended that the structural effects caused by the previous treatments are largely, if not entirely, responsible for the changes noted.

HARD AND SOFT CONSTITUENTS

Many of the alloys most useful from the industrial standpoint consist of two or more constituents which vary quite widely in their characteristics. One of the constituents is often relatively very soft and ductile, while a second is hard and brittle. Such a condition occurs in steels, in aluminum casting alloys, and in

bronzes, particularly those for bearing purposes. The softer constituent gives the required ductility, while stiffness and strength are contributed by the harder one which is disseminated throughout the soft matrix. The relative proportions of the two determine the properties of alloys of the same general series which differ among themselves in their percentage composition.

Fig. 1 shows a specimen of cast zinc-bronze (approximately 88 per cent copper, 10 tin and 2 zinc) which was stressed in tension until fracture occurred. The soft ductile copper-rich matrix easily adapts itself to the applied loading, the hard brittle tin-rich constituent is shattered and broken, as shown, when stressed sufficiently. Similar cases may be noted in other alloys such as an aluminum casting alloy containing Cu 1.8 per cent, Mg 1.7 per cent and Mn 1.2 per cent. The hard constituent separating from such an alloy, consisting of a compound of aluminum and copper (CuAl_2), is sufficient in amount to form a continuous network throughout the alloy. The course or path of the fracture of a test specimen is determined by this network; thus the results of a tension test of such a material depend primarily upon the amount and the properties of this constituent.

SOFT DUCTILE CONSTITUENTS

Copper and lead do not alloy with each other in the sense that most metals do; neither solid solutions nor definite compounds of the two are formed. An "alloy" of these metals consists only of a mechanical mixture of the two metals, the intimacy of the mix depending largely upon the care used in preparation and the skill of the operator. The "alloy" may be considered, for convenience, as a copper sponge, the interstices of which are filled with globules of lead.

Although both copper and lead, when reasonably pure, are highly ductile, the mixture of the two behaves in a rather anomalous manner when tested. The behavior of the material when stressed in tension is somewhat as might be expected. It is somewhat ductile, but is decidedly inferior to metallic copper in its properties. Thus a tension test of an alloy consisting essentially of 40 per cent lead and 60 per cent copper gave the following results: Ultimate strength in tension, 10,650 lb. per sq.in.; elongation in 2 in., 8.5 per cent, and reduction of area, 7.5 per cent. The continuity of the copper matrix is so broken up and weakened by the inclosed globules of lead—which of course are of very low tensile strength—that the resulting tensile properties are correspondingly lowered. The properties measured are essentially those of the copper sponge and the properties of any particular specimen are inferior to those of a specimen containing the same amount of copper in the form of a solid, but smaller, rod.

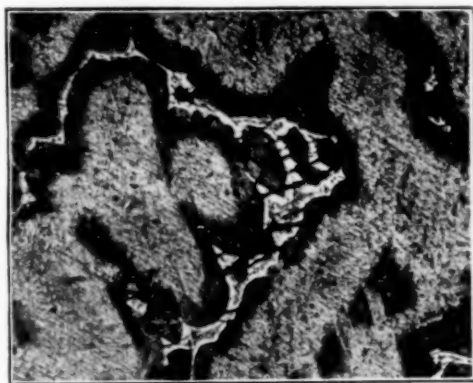


FIG. 1. CAST ZINC-BRONZE PULLED AT RIGHT ANGLES TO CRACKS IN BRITTLE CONSTITUENT. $\times 250$
Etched with concentrated NH_4OH

Published by Permission of the Director, Bureau of Standards.



FIG. 2. Cu 60, Pb 40
BROKEN IN COM-
PRESSION. $\times 1$

The appearance of the fractured specimen of the "alloy" when tested in compression is shown in Fig. 2. Although each of the two constituents is decidedly ductile under compression, the mixture of the two behaves in a manner characteristic of a brittle material. Instead of flattening to any appreciable extent the specimen shears in a manner such as is expected, for example, in cast iron. The inclosed globules of the lead undoubtedly contribute largely to the failure of the specimen in the manner shown by their action as a "lubricant." The ultimate strength in compression of lead is very much lower than that of copper; thus the lead yields under the applied loading and "flows" long before the copper is stressed to a degree which would cause appreciable deformation.

ORIENTATION OF TEST SPECIMEN

It is known that the mechanical working which is necessary for forming a metal after casting affects the structure to a very marked extent. The worked material has a more or less "fibrous" structure depending largely upon variations in composition across a section of the ingot used and particularly upon the various inclusions within the metal. After the working of the metal these are arranged in rather definite lines the course of which is determined by the shaping of the particular piece. It is evident that the mechanical properties, when measured across a laminated or fibrous material, will be quite different from those of the same material the test specimen of which was cut *parallel* to the course of the fibers. In the latter case—which covers by far the greater majority of the test specimens used in industrial testing—the mechanical properties are not seriously affected. It is only when it is specified, as is done for example in gun forgings, that the test specimen shall be cut transversely to the direction of working that the effect is marked. Fig. 3 shows the appearance of a specimen of gun steel (carbon 0.48, manganese 0.76, nickel 2.85, sulphur 0.02, phosphorus 0.02), broken in tension, the following results being obtained: Yield point (by divider method), 79,000 lb. per sq.in.; ultimate strength, 83,000 lb. per sq.in.; reduction of area, 3.5 per cent; elongation in 2 in., 3.5 per cent. The



FIG. 3. FRACTURE OF
GUN FORGING. $\times 2$

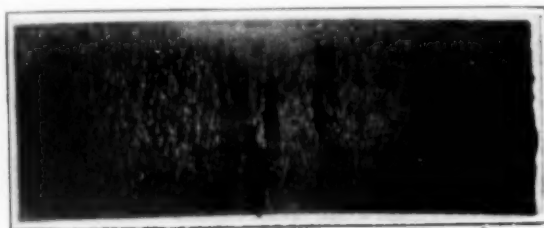


FIG. 4. LONGITUDINAL MEDIAL SECTION OF
TEST PIECE, FIG. 3
Etched with copper ammonium chloride. $\times 2$.

very marked banded structure of the material which macroscopic examination (Fig. 4) showed was caused by threads of inclusions is unquestionably the reason for the very low ductility shown by the material. From the microstructure of this material (Fig. 5) one has reason to expect that considerable ductility would be shown.

In Table I are summarized the results obtained by testing duplicate transverse and longitudinal specimens

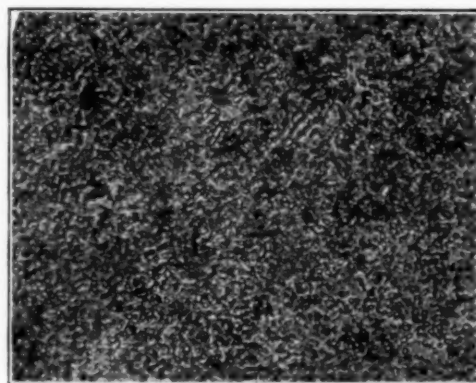


FIG. 5. MICROSTRUCTURE OF FIG. 3.
Etched with 2 per cent alcoholic HNO_3 . $\times 500$

TABLE I. TENSILE PROPERTIES OF FLAKY STEEL AS REVEALED BY TRANSVERSE AND BY LONGITUDINAL TEST SPECIMENS

Specimen No.	P-Limit, Lb. per Sq. In.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Reduction of Area, Per Cent	Elongation in 2 In., Per Cent	Modulus of Elasticity, Lb. per Sq. In.
T	53,500	56,100	59,200	1.5	1.5	29,000,000
T1	65,000	67,000	92,950	5.0	3.5	29,000,000
L	62,500	65,000	106,500	52.0	26.5	29,500,000
L1	62,500	65,000	106,850	50.5	26.0	29,500,000

of the same material in tension. The metal chosen was a type of defective steel encountered particularly in gun forgings, which has been designated as "flaky steel" of a composition very similar to that given above. Agreement among metallurgists as to the origin of these defects, "flakes," has not yet been reached.

Defective material of the type used when tested in the ordinary manner shows apparently very superior properties, particularly in ductility. However, when a specimen cut transversely from the material is tested,



FIG. 6. MICROSTRUCTURE OF CAST ZINC-BRONZE AT FRACTURE. $\times 3$
Etched with alcoholic ferric chloride.

it behaves very differently and breaks with practically no ductility. The elastic properties are not seriously affected, however, even when the internal defects are sufficient to reduce the ultimate strength of the material to approximately only 50 per cent of the normal value. When such material is subjected to some of the dynamic methods of testing, impact, fatigue, etc., the difference in the results obtained for the transverse specimen is usually even more marked than the results given above for the tension test.

It has been suggested that the grain size of a metal has a pronounced effect upon many of the properties of a material. Coarsely grained metals are quite universally regarded with disfavor, although there appears to be no evidence at hand to demonstrate the unsuitability of such material for many purposes. The brittleness, usually attributed to large grain size, is not very well revealed by a tension test, at least as ordinarily carried out. Fig. 6 shows a section of a coarsely grained tension specimen of cast bronze, (88:10:2) broken in tension. Fracture is intracrystalline. The structure indicates that the mechanical properties were determined to a very large degree by the fact that the entire cross-sectional area at the point at which the fracture occurred comprised only a few large grains. There was nothing, however, to indicate this until the specimen was sectioned and its structure examined.

A shock or impact test reveals the effect of coarse grain in a much more striking manner. Fig. 7 shows the appearance of a specimen of low-carbon steel, after testing in a Fremont impact testing machine which showed exceptionally superior qualities. The microstructure of Fig. 8 suggests that the superior shock-

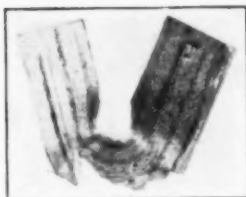


FIG. 7. FREMONT IMPACT ON TOUGH LOW-CARBON STEEL. $\times 1.5$



FIG. 8. MICROSTRUCTURE OF FIG. 7. $\times 100$
Etched with 2% HNO_3 in alcohol

resisting properties were undoubtedly produced by quenching the steel from a high temperature, probably above that of the A_1 transformation. Another piece of the same steel, which had evidently been overheated in annealing and which showed a coarsely polyhedral structure, broke off easily and squarely. The entire lack of ductility of the coarsely grained specimen as compared with the superior shock-resisting qualities of the same steel when properly treated affords striking evidence of the influence of grain size upon mechanical properties.

PHYSICAL STATE OF MICROSCOPIC CONSTITUENTS

The relative size, arrangement and method of distribution of the various constituents which make up the structure of an alloy bear a close relationship to the various properties of the alloy. This is best noted in a binary alloy—for example eutectoid carbon steel—different specimens of which have been subjected to various thermal treatments with the express purpose of producing the variations in the microstructural features suggested above. Precautions of course must be taken that no phase changes in the alloy occur and that it is

in stable equilibrium throughout, the differences produced in the structure being physical ones only.

Considerable investigational work has been done to show how the mechanical properties of carbon steels, particularly those of eutectoid composition, vary with the physical state of the pearlite, the steel being in the softened state throughout and the pearlite ranging from the lamellar type through various stages to the completely "divorced" or spheroidized condition. The work of Hanemann¹ and of Howe² illustrates this.

The influence of the physical state of the pearlite in steel upon the properties is well shown by a study of the magnetic characteristics of the same steel after various treatments.³ The various specimens of the steel (carbon 0.85 per cent, manganese 0.28) were cooled from the same temperature (800 deg. C.) at rates so chosen that the structure of the different specimens varied from a fine sorbitic condition to a "divorced" or spheroidized pearlite. Without discussing here the significance of the various properties revealed by the magnetic tests, it may be noted that the properties of the steel are affected to a marked degree by the changes which have been brought about in the physical state of the pearlite. Corresponding differences in the mechanical properties would also be found upon testing, although perhaps of not so great a magnitude as in the magnetic properties, since the magnetic tests are much more sensitive than the ordinary mechanical ones and often reveal changes which are detectable by almost no other means.

CHEMICAL PROPERTIES AS AFFECTED BY STRUCTURE

The chemical property of metals and alloys which is probably most important industrially is that designated by the rather loose term of "solubility." Upon this property depends the etching of metallographic speci-

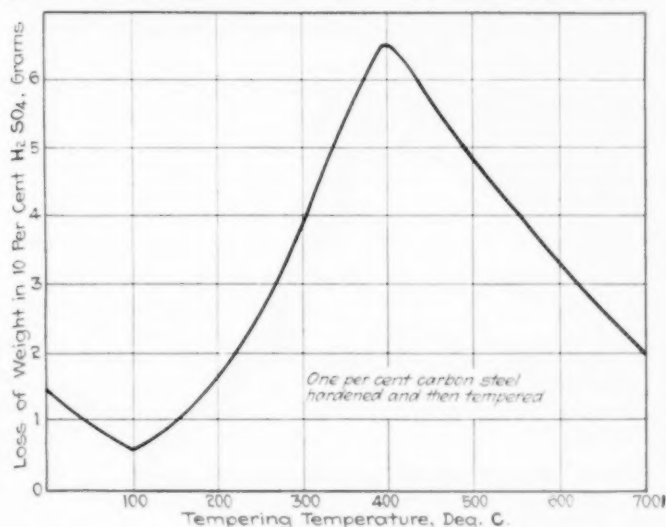


FIG. 9

Variation in the solubility of 1% carbon steel in dilute sulphuric acid, after hardening and tempering to different temperatures. (Hanemann.)

mens, the coloring of metallic surfaces, the corrodibility of materials under service conditions, and often, by the selective corrosion of certain constituents, the complete deterioration of the entire alloy in service. This property of an alloy is often influenced to a marked degree by the structure.

¹H. Hanemann and F. Morawe, "Über den körnigen Perlit und seiner Bedeutung für die Wärme Behandlung des Stahls." *Stahl und Eisen*, vol. 33, part 2, p. 1359 (1913).

²H. M. Howe and A. G. Levy, "Notes on Pearlite," *J. Iron & Steel Inst.* vol. 94, p. 216 (1916).

³C. Nusbaum and W. L. Cheney, Bureau of Standards Sci. Paper 408 (1921).

SOLUBILITY OF TEMPERED STEELS

It is quite well recognized that the solubility of steel varies considerably according to the heat-treatment which it has received. Fig. 9 illustrates this variation of solubility according to treatment,⁴ which may be well shown in the following manner: Harden a rod of high-carbon steel (approximately 1 per cent carbon) by quenching in water from a temperature of 765 deg. C. and then differentially temper it by heating one end to approximately 850 deg. C. while the other is kept cool with water. Thus the rod is tempered at different points along its length at all temperatures between the two extremes. When immersed in dilute sulphuric acid (20 per cent solution) for a day the acid will eat into the rod at different rates, forming a neck close to the reheated end.

Considerable attention has been given to this property of tempered steels by foreign metallurgists, and it has been shown, as is illustrated by Fig. 9, that the rate of solubility can be used as an indication of the tempering a specimen of steel has received. Maximum solubility corresponds to a tempering at 400 deg. C. A special

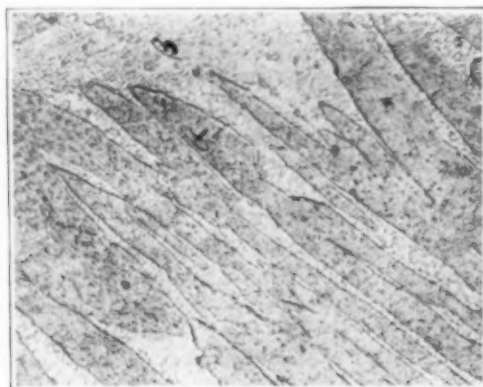


FIG. 10
Microstructure of Muntz metal showing the two constituents α and β . $\times 500$. Etched with ammonium hydroxide and hydrogen peroxide.

name, Osmondite, has been given to steel in this particular condition on account of its characteristic properties.

Thus it is evident that the rate of solution is profoundly affected by the structure of the steel. In the form of the solid solution the material is the least soluble; as the degree of tempering is increased and the carbide held in solid solution is progressively precipitated, the rate progressively increases. The maximum solubility occurs in the troostitic steel after the simple solid solution has been changed by tempering into a state of agglomeration resembling that of an emulsion. The material in this condition is not resolvable under the microscope into its constituent parts. As the tempering is continued, progressively higher temperatures being used, the ultramicroscopic particles increase in size until finally the ordinary microscopic examination reveals them. This increase in the size of particles of the constituents is accompanied by a decreased solubility, although the fully annealed specimen is somewhat more soluble than is the material in its initial or fully hardened state.

CORROSION

This term when strictly used refers to the tendency of metals to revert to the stable form in which they

⁴H. Hanemann, "Einführung in die Metallographie und Wärmebehandlung," p. 87.



FIG. 11
Microstructure of a corroded sheet of Muntz metal after 7 years exposure in sea water. $\times 500$. Etched with ammonium hydroxide and oxidized in the air.

occur in nature—that is, the oxide. The subject is so broad and the contributing causes so many and so varied that considerable differences of opinion are held as to the mechanism by which the process of corrosion is brought about. Only a brief mention will be made here of how structural features aid in the process.

In general the corrosive attack of a metal is more pronounced in the direction of the "fibers" than across them. This is most marked in case of accelerated corrosion by exposure to sea air, sea water or similar conditions and is found in all types of readily corrodible alloys if in the wrought state. This may be attributed largely to the mechanical effect of inclusion streaks by affording lodgment for moisture so that the attack at such points is accelerated and access to the interior more readily gained along the line of the inclusion. Similar instances have been noted in wrought aluminum alloys in which it appears that the difference in the electrochemical properties of streaks of the metal in various



FIG. 12. FRAGILE CONDITION OF SHEET OF FIG. 11

stages of cold-working is responsible in a large degree for the fibrous appearance of the corroded ends of wrought rods.

Brass of the type termed Muntz metal, approximately 60 per cent copper and 40 per cent zinc, exemplifies well the specific effect of a metallographic constituent upon corrosion. Such a brass has a duplex structure, as is shown in Fig. 10, the α constituent being much richer in copper than the β . The zinc-rich constituent is quite readily attacked by sea water, the difference in the electrochemical potential of the two being a contributing factor. The zinc from the β is leached out and a spongy mass of "copper" remains filling the spaces previously

occupied by the β . (Fig. 11.) Thus the alloy is converted into a weak brittle mass consisting of a "sponge" of the more or less attacked α constituent and the pulverulent material resulting the disintegration of the β . Material of this kind in the form of sheets often becomes so brittle that it can be readily broken into small fragments in the fingers. (Fig. 12.)

A soft ductile metal like lead may under some conditions of accelerated corrosion become so brittle that it can be crumbled to powder in the fingers. This is most apt to occur if the lead is somewhat impure. Each grain, however, may retain its initial ductility and other characteristic properties of lead. The corrosive attack of the metal in one case studied^a was essentially intercrystalline in character, due in all probability largely to the impurity contained by the metal (1.09 per cent tin), although it was shown that lead of exceptionally high purity (99.99 per cent) is subject to intercrystalline brittleness under certain conditions. In lead cable sheaths the tin and other impurities present exist as constituents of a eutectic surrounding the crystals of lead; thus the corrosive attack will be localized to a large extent and the metal as a whole will show "intercrystalline brittleness."

The Manufacture of Arsenic Trioxide*

BY GEORGE VIE

THE manufacture of arsenic trioxide comprises two distinct stages—namely, production of the crude trioxide and its refining. Each of these stages comprises several different operations.

The production of the crude trioxide necessitates drying of the ore, roasting, purification of the arsenic trioxide vapors obtained in the roasting and their condensation.

The refining of the trioxide necessitates washing, drying, distillation and condensation of the refined product.

TREATMENT OF THE ARSENIC ORES

The arsenical pyrite used in the manufacture of the arsenic trioxide is first crushed by jaw crushers and then ground in a rotary ball mill. The ground product is then washed and freed from foreign matter, and as this product contains about 25 per cent moisture it is necessary to dry it before it is sent to the roasting furnaces. Formerly the drying was done at the top of the roasting furnaces by the waste heat, but this method had the disadvantage of cooling the furnace to an appreciable degree and thus reduced the roasting efficiency. At present the drying is done in mechanical driers (Fig. 1), which consist of an oven *A* into which the wet product coming from the washery in cars *B* is fed and conveyed by a screw conveyor *C* rotating at a given speed so as to keep the product in a loose state and convey the dried material to the outlet *D* leading to a bucket elevator. The oven is heated by a furnace *F*. By the use of this drying arrangement no dust fills the building and the steam is carried away through hoods and chimneys.

ROASTING OF ARSENICAL PYRITES

The arsenical pyrites properly ground and dried are conveyed by a bucket elevator to the charging hopper of the roasting furnaces. The roasting operation is sim-

ilar to that used in roasting copper and iron pyrites. Hand-rabbed furnaces of the Maletra type are now entirely replaced by mechanically rabbed furnaces, thus reducing the manual labor cost and the dangers of poisoning. The furnace used is of the vertical type, made of sheet iron lined internally with refractory material and externally with insulating material. The

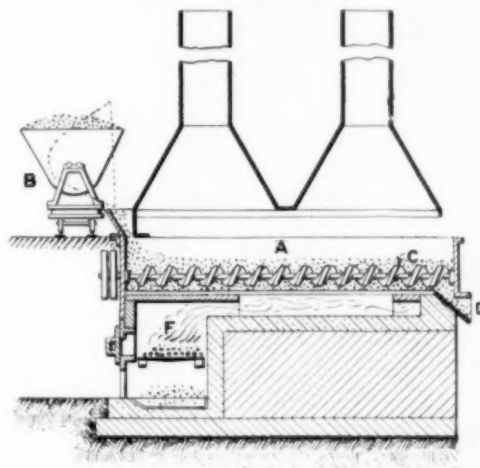
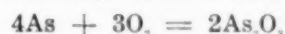


FIG. 1. MECHANICAL DRIER

dimensions of the furnace are from 6 to 10 m. high and from 3 to 5 m. in diameter. A centrally located vertical shaft provided with rabblers rotates at a given speed. The dried pyrite enters the furnace at the top. A series of annular slabs of 10 cm. thickness with plane upper surfaces and curved bottom surface are placed in the interior of the furnace. Each slab is provided with openings for the charging of the pyrite and for the upward circulation of the arsenic trioxide vapors. The lower part of the furnace is fitted to receive the roasted pyrites, which now contain only a negligible proportion of arsenic. The shaft and rabblers are hollow and cooled by a cold air current supplied by a ventilator. This air current provides also the needed oxygen for the oxidation of the ore and facilitates the escape of the arsenic trioxide as soon as formed.

The oxidation takes place according to the equation



Peep holes in the furnace walls located at the levels of the rabblers permit the easy inspection of the operation of the furnace and of the rabbling mechanism.

PURIFICATION OF THE ARSENIC TRIOXIDE VAPORS

During the roasting process the material is continuously being ground by the rotation movement of the rabblers, so that although the rotation is usually only 5 r.p.m., sufficient finely pulverized pyrite is carried along by the vapors to discolor the final product. It is therefore necessary to separate these solid particles before the vapors reach the condensing chambers. This is done by the use of a dust separator placed at the furnace vapor outlet. This separator consists of an insulated chamber containing two fine-mesh rotating cylindrical screens through which the vapors have to pass. A large part of the dust is retained by the first screen and the vapor passing through the second screen is practically free of solid particles. The cylinders rotate at a speed of 2 r.p.m. The screens are kept clean by two cylindrical drums provided with metallic brushes which rotate in a direction opposite to that of

^aFrom *L'Industrie Chimique*, December, 1920, pp. 426-429.

^bH. S. Rawdon, "Intercrystalline Brittleness of Lead," Bureau of Standards Sci. Paper 377 (1920).

the screens. The brushing is very efficient and the screens are always clean and offer very little resistance to the passage of the vapors.

CONDENSATION OF THE ARSENIC TRIOXIDE VAPORS

The purified vapors are drawn by a suction fan into a series of sheet lead chambers, Fig. 2. A very slight vacuum is maintained in the roasting furnace. To overcome the resistance offered to the vapors by the purifier and pipe lines the fan has to produce a vacuum of from 60 to 80 mm. of water.

The condensing chambers are separated into equal parts by vertical baffle plates, thus increasing the condensing surfaces. These baffle plates are of sheet lead,

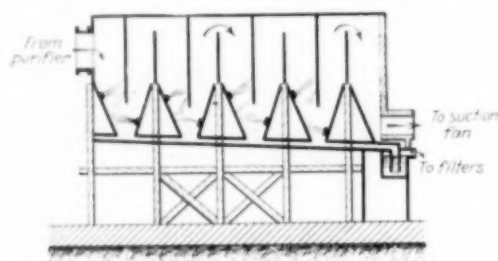


FIG. 2. CONDENSING CHAMBERS

the same as the chamber walls. The use of sheet lead is necessary because SO_2 from the roasting furnace is carried over into the chamber and would soon destroy any other metal lining and baffles.

About a third of the height of the chamber is in the form of a truncated cone. Rapid condensation is facilitated by the use of sprays of cold water. The bottoms of the chambers are connected to a manifold conduit leading the condensed milky product into a vat provided with agitator to mix the product before it is sent to the filtering room.

The chamber nearest to the fan is not provided with water sprays, so that only dry gas passes the fan. The thoroughness of the condensing operation can be judged by the color of the gases leaving the fan. If they are whitish, it indicates that the condensation is not complete and that heavier water spraying is required.

FILTRATION

The condensed milky product is filtered in a specially constructed filter. This filter consists of a shallow tank, 4 m. long, provided with a false bottom spaced 20 cm. above the fixed bottom. The perforated false bottom is covered with filter cloth. The filtration is facilitated by continuous stirring with a revolving helicoidal propeller, the helices of which reach within a few centimeters of the filter cloth. This propeller will serve also to convey the partly dried product to the final drying compartments.

When the tank is filled with the milky condensate pumps of 13 cu.m. per hour capacity evacuate the space between the two bottoms and the greater part of the water is soon filtered out.

There are a series of such tanks, and each tank has its own vacuum pump. When the contents of a tank have been partly freed of the water the cake is somewhat dried by the circulation of a strong current of air. The cracks forming in the drying cake are kept well closed so as to avoid short circuiting of the air current. Experience has proved that by adding dry As_2O_3 to the partly dried mass the degree of dryness

which can be realized by this air-current drying is greatly increased, and it also prevents the helicoidal propeller from getting jammed by the sticky product.

DRYING

The preliminary air-dried product, which still contains from 20 to 25 per cent of moisture, is completely dried in a reverberatory furnace, or better still, in a horizontal rotary drier. This latter consists of a horizontal sheet-iron cylinder having about 10 sq.m. drying surface and rotates at a speed of 10 r.p.m.

The feeding to the drier is made by the helicoidal propeller and the sticking of the material to the sides of the cylinder is prevented by the use of a smooth porcelain lining. The drying temperature is below 180 deg. C., thus avoiding any distillation of arsenic trioxide and its subsequent loss. The resulting steam escapes to the atmosphere through a chimney placed above the outlet from the drier. The dried product is led to bucket elevators and conveyed to the refining department.

REFINING OF THE CRUDE ARSENIC TRIOXIDE

The refining of the crude arsenic trioxide involves the following operations: Distillation, condensation, filtration and drying.

The distillation of the dried crude arsenic trioxide can be carried out in different ways. Some plants still use fireclay retorts similar to those used for the manufacture of coal gas, but the charging of the retorts requires very difficult and long manipulation. The latest improvements for industrial arsenic trioxide distillation consists in the use of a furnace 3 to 4 m. in diameter and about 50 cm. deep made of pig iron. The cover is provided with openings for the inlet of the crude material brought to the hopper by bucket elevators and for the outlet of the vapors. An axial shaft provided with rabbling arms rotating with a speed of 5 r.p.m. serves to stir the material uniformly and avoid the sticking to the bottom. It has been found that 245 deg. C. is the most convenient distillation temperature. This type of furnace offers the advantages of fuel economy besides those of mechanical charging, rabbling and uniform distillation. Industrial average data have shown that about 70 kg. of coal is required per 100 kg. of refined arsenic trioxide.

The final condensation takes place in lead-lined wooden chambers in the form of inverted rectangular pyramids. Each chamber is divided into two compartments so as to increase the condensing area. About 3 kg. of trioxide is condensed per sq.m. of condensing area. The outlet from the condensing chambers leads to a coke-filled tower, in which the last traces of the trioxide are condensed by a continuous spray of water.

A porcelain screw conveyor operating in a trough connected to the bottoms of the condensing chambers removes the refined material to the packing department.

The finished product, As_2O_3 , is finely powdered, perfectly white and quite chemically pure, analyzing 99 per cent As_2O_3 .

Importation of Dyes and Dyestuffs Into Egypt

The amounts and values of dyes and dyestuffs (exclusive of natural and synthetic indigo) imported into Egypt for the first eight months of 1919 and 1920, respectively, were 104,700 and 189,400 lb., valued at \$98,000 and \$146,000. Values are converted into dollars at the normal rate of exchange (20.23 piasters = \$1).

Recovery of Potash Alum and Sulphur at Tonopah

Description of the Process and Plant Operated by the Western Chemicals, Inc., in the Recovery of Potash Alum and an Agricultural Grade of Sulphur by Extraction and Flotation

BY LINDSAY DUNCAN

Consulting Engineer, San Francisco

ABOUT thirty-five miles west of Tonopah, Nev., and six miles south of the Tonopah & Goldfield R.R. there is a deposit containing potash alum and free sulphur. The deposit was first described by J. E. Spurr, although it had been previously prospected and located as a sulphur mine. The alum and sulphur occur together in thin stringers running throughout a mass of decomposed rhyolitic tuffs. More than 100,000 tons has already been blocked out, and the estimated probable tonnage is more than 1,000,000. The deposit is owned by the Western Chemicals, Inc., of Tonopah, Nev., and a plant has recently been put in operation for the recovery of the alum and sulphur.

A typical analysis of the run-of-mine ore is given in Table I. With the exception of a very small amount of calcium sulphate, the alum is the only soluble sub-

stance in the ore. Potash alum is very much more soluble in hot than in cold water, while the solubility of the calcium sulphate does not vary with the temperature. It is therefore possible to recover the alum free from calcium sulphate by merely dissolving the ore in hot water and crystallizing the alum by cooling the solution, leaving the calcium salt in solution.

various compositions were tried and found unsuitable and as finally constructed wood, rubber, chemical and antimonial lead were the only substances allowed to come in contact with the alum solutions after leaving the ball mill, and the mill is lined with silex blocks set in water glass and sand and Danish flint pebbles are used for grinding.

The method of treatment consists in first dry-crushing the ore to $\frac{3}{4}$ in. by a jaw crusher and then grinding to 80 to 100 mesh in a 5 x 14-ft. pebble mill, the grinding being done in warm solution from the first cone.

The pulp from the pebble mill is delivered to the dissolving section of the plant by an air lift. The dissolving section consists of five 10 x 8-ft. propeller-type agitation tanks, five 5 ft. 6 in. Allen cones and five air lifts. The process is essentially that of continuous counter-current leaching in which the pulp is dewatered at each of the five stages. The agitator tanks are made of redwood, the propellers of antimonial lead and the propeller shafts are lead covered. All pipes leading to or from the tanks are of lead. The Allen cones are constructed of redwood and all metal parts are of antimonial lead. The air lifts are formed of redwood pipe; the tail pipe is a machine-banded stovepipe with a solid redwood plug in the bottom; the discharge pipe, which is exposed to the action of the solution on both sides, is solid bored. The air pipe is of lead where submerged.

FLOW SHEET OF THE PLANT OPERATION

Referring to the flow sheet (Fig. 4), the pulp leaving the ball mill flows to No. 1 air lift and is discharged to No. 1 agitator. It then flows to No. 1 Allen cone, where it is dewatered; the spigot product drops to No. 2 air lift, which in turn discharges to No. 2 agitator, the cycle of operations being repeated in each succeeding unit. The spigot product of the fifth cone, which contains less than 1 per cent of soluble alum, is delivered to the flotation unit.

The pulp remains in each agitator about three hours,

TABLE I. ANALYSIS OF RUN-OF-MINE ORE

	Per Cent
$K_2Al_2(SO_4)_4 \cdot 24H_2O$	20.0
S (free)	15.0
SiO_2	58.8
Al_2O_3	2.6
$CaSO_4$	2.1
$CaCO_3$	1.2
Fe_2O_3	0.3
	100.0

stance in the ore. Potash alum is very much more soluble in hot than in cold water, while the solubility of the calcium sulphate does not vary with the temperature. It is therefore possible to recover the alum free from calcium sulphate by merely dissolving the ore in hot water and crystallizing the alum by cooling the solution, leaving the calcium salt in solution.

MATERIAL USED IN THE PLANT DESIGN AND PROCESS OF TREATMENT

In designing the plant considerable difficulty was caused by the fact that the hot saturated alum solutions would attack most of the materials commonly used in construction. Aluminum, copper, iron, tin and nickel in



FIG. 1. POTASH ALUM-SULPHUR DEPOSIT



FIG. 2. FACE CUT INTO ORE

and as about four hours is required to dissolve completely the alum from the pulp, under operating conditions, it is evident that the solution of the alum is complete before the pulp leaves the second agitator. The function of the last three agitators and cones is simply that of washing the pulp and replacing the alum-laden solution with fresh water. Fresh hot make-up water is admitted to the fifth agitator and together with the agitated pulp goes to the fifth cone. The overflow solution from the fifth cone flows to the fourth air lift; a portion is, however, returned to the fifth air lift to maintain the proper dilution of the pulp. The solution is advanced in this manner progressively from the fifth to the first agitator, increasing in alum content. The third, fourth and fifth agitators accomplish the washing and the solution takes place in the first two. The overflow solution from the first Allen cone is divided into two portions, part going to the crystallizing vats, the remainder to the pebble mill, from which it returns to the first air lift with the freshly ground ore.

Live steam is used to heat the solutions and is admitted to the vortex of the agitators, where it is drawn down into and distributed throughout the agitated liquid by the propeller. Thermostatic valves control the temperature of the solution in the agitators at 85 deg. C. Lead-covered bulbs governing the steam valves are inserted through the sides of the agitator tanks.

The portion of the solution overflowing from No. 1 Allen cone, which is not used in the pebble mill, is forced by a 1-in. lead-lined centrifugal pump through Sperry filter presses. The presses have wooden plates, and woolen filter cloths are used. Each filter has a filtering area of 100 sq.ft. and a cake capacity of 5 cu.ft. The two filters are set in parallel and are valved with lead-lined stopcocks so that either press can be cut out for cleaning without interfering with the operation of the other. The filters remove colloidal material that may be present in the overflow from the first Allen cone, and the filter cake is delivered to the flotation cell feed box.

The filtrate flows to one or more of the four 29 x 6-ft. crystallizing tanks. After the alum has crystallized



FIG. 3. PLANT OF WESTERN CHEMICALS, INC.

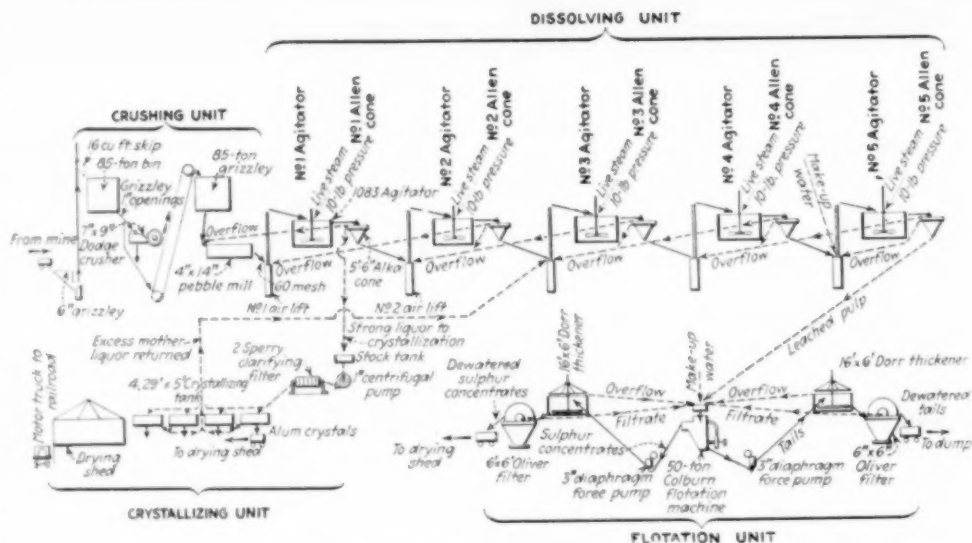


FIG. 4. FLOW SHEET OF PROCESS

from the solution in a tank the mother-liquor is returned to No. 3 agitator and the tank is again filled with pregnant solution. When a tank is finally filled with alum crystals the mother-liquor is completely drained off. The crystals are removed through an acid-proof wooden gate valve in the bottom of the tank, fall into cars and are trammed to the drying shed.

SULPHUR RECOVERY

The underflow from No. 5 Allen cone, which has been practically denuded of alum and contains approximately 30 per cent of moisture, is delivered by launder to a feed box for the flotation cell, where it is mixed with the return water from the flotation cell. Hot make-up water is added at this point, as it has been found that a better recovery of the sulphur and a higher grade of concentrate is obtained by the use of hot water in the flotation cell. From the feed box the pulp flows directly to a six-compartment Colburn flotation cell which has a capacity of about 2½ tons of feed per hour. The sulphur concentrates are pumped to a 6 x 6-ft. Oliver filter and the filter cake is trammed to the drying shed. The filtrate flows back to the feed box. The tailing product is pumped to a 16-ft. Dorr thickener, the underflow from the thickener is filtered by a 6 x 6-ft. Oliver filter and the overflow returns to the feed box. The filter cake is trammed to a dump and the filtrate flows to the feed box. These steps are necessary to conserve water, which is very difficult to obtain in a Nevada desert. The sulphur recovery is from 85 to 90 per cent and the grade of the concentrate from 80 to 85 per cent. The impurity is almost entirely silica. The product is particularly desirable for dusting vines.

CAPACITY OF THE PLANT

The capacity of the entire plant is governed by the mechanical loss of alum which it is economical to allow. A loss of 5 per cent has been decided upon and under these conditions the plant will produce about ten tons of c.p. alum and ten tons of 85 per cent sulphur concentrates per day.

The plant was designed and constructed by Duncan & Lindley, Mills Bldg., San Francisco. The chemistry of the process was reported upon by Dr. Merle Randall and the geology of the deposit by Dr. A. C. Lawson, both of the University of California.

Silver Peak, Nev.

Cost of Fixed Nitrogen in Norway

By T. C. HAGEMANN*

THE object of the present article is not to make an accurate calculation of the cost of construction and working expenses of a plant for the manufacture of nitrates by the electrical oxidation of air, but, taking into consideration the market price of the products, to show that this process is profitable in Norway. If one intended to do so, it would be absolutely necessary to know the location of the plant in contemplation and the exact cost of materials, machines and apparatus, besides local prices of power, raw materials and wages.

STEPS IN THE PROCESS

Let us first outline the steps in an arc-process plant.

The air to be treated is let into a chamber, where it passes through an electrical arc, which by some artificial means is given an increased area in order to heat the air so intensely that a part of the nitrogen burns—that is, combines with the oxygen and forms NO.

The nitrous gas, which at the outlet of the furnace has a temperature of about 1,000 deg. C., passes first through a steam boiler, where it gives up the greater part of its heat to the water in the boiler, thus producing steam of a convenient pressure and temperature. The further cooling of the gas (from about 200 deg. C. to about 40 deg. C.) occurs in coolers fitted with tubes of aluminum, this part of the heat being lost with the cooling water.

During the following stay of about one minute in the oxidation chamber the nitrous oxide has time to combine with one more molecule of oxygen and forms NO₂.

The gas is now fit for absorption and accordingly passes through a series of towers of granite—generally four—filled with broken quartz. On the top of the fourth tower water enters as a spray and runs out at the bottom in form of weak nitric acid. A portion of this acid is forced back to the top of the same tower, while the rest is forced to the top of the third tower, and so on. At the bottom of the first tower it meets the fresh gases from the oxidation chamber, and a weak nitric acid containing about 30 per cent HNO₃ by volume is produced.

CONVERSION TO CALCIUM NITRATE OR SODIUM NITRITE

This acid is not suitable for transportation, and must first be concentrated to the strength of 96 to 98 per cent HNO₃, in which form it can be transported without any difficulty in containers made of 98 per cent aluminum; or it can be neutralized with ammonia to form ammonium nitrate or with calcium hydrate to form calcium nitrate ("Norwegian saltpeter").

During the war there was a great demand for ammonium nitrate, but now, in peace time, preference is given to the more pacific material calcium nitrate.

In this case, we allow the acid to pass through open towers, filled with limestone, and afterward we destroy the small amount of remaining acid in the solution with slaked lime. We then remove a part of the water content in evaporators fitted with copper steam coils, until the solution contains 13 per cent N, utilizing steam from the boilers in which we have cooled our gases. We now pass the solution into flat pans or in a more improved apparatus, allow it to solidify on rotating water-cooled drums. The crude lumps from the pans,

or from the surface of the drums, are broken up and then packed into barrels, ready for marketing. By the process described above, we can utilize about 80 per cent of the nitrous oxide content of the gases.

In order to recover an additional 15 per cent, the gas from the fourth "acid tower" is led into a tower, which may be made of iron, filled with broken quartz, and through which is pumped soda lye, until the solution at the bottom of the tower contains practically pure sodium nitrite.

Owing to the fact that the market for this very valuable product, NaNO₂, is rather limited, we convert it to the less valuable product sodium nitrate by means of nitric acid. The solution is then evaporated, crystallized in flat pans or, more rationally, in finishers, fitted with salt boxes, centrifuged, dried with hot air and packed into sacks ready for market.

ESTIMATED YIELD

Concerning the quantity of the finished products, we are in any case safe, if we figure on a yield of 540 kg. HNO₃ (calculated at 100 per cent per kw.-yr., or 62½ g. per kw.-hr.). For a medium-sized factory, say of 40,000 kw., the amount, after having subtracted the power for working the auxiliary machinery, will be about 20,000 tons HNO₃, equivalent to 4,500 tons N, in the form of 29,000 tons Norwegian saltpeter with 13 per cent N, and 4,400 tons sodium nitrate with 16.5 per cent N.

Of raw materials there will be required 15,000 tons limestone, 500 tons lime and 2,500 tons soda.

For the economical calculation I prefer to figure in Norwegian kroner, being most familiar with that coinage. (1 kr. normal exchange or parity = \$0.268, at present market = \$0.18.)

The market price of the nitrogen in the above-mentioned products is about 3,000 kr. per ton. Total selling price for 4,500 tons is 13,500,000 kr.

Approximate running expenses are:

	Kroner
Power, 40,000 kw. @ 100 kr.....	4,000,000
Administration and wages.....	1,500,000
Raw and other materials.....	1,100,000
Packing	1,000,000
Sundries	400,000

Total 8,000,000

Balance: 13,500,000 kr. — 8,000,000 kr. = 5,500,000 kr.

The investment is estimated to be about 20,000,000 kr., and taking 7½ per cent, or 1,500,000 kr., for amortization, the profit will be about 4,000,000 kr.

As will be seen from the above, the cost of power represents half of the total running expenses, and indeed, this item, together with the relative yield of the future, is of vital importance when considering the cost and returns of any one individual factory.

DEMAND FOR THE PRODUCT

During my stay in the United States two years ago I was told that the Norwegian saltpeter was not salable in large amounts, because it is not applicable to the manufacture of the mixed fertilizer demanded by American farmers. Afterward I saw the same statement made in the technical journals. The fact is, however, that this product, calcium nitrate, is exported from Norway in increasing amounts, and if the claim of the producers that this fertilizer, especially on lime-poor soil, is more valuable than other fertilizers, is proved to be correct, it seems likely that the American farmers will find it to their interest to use it.

*Consulting Engineer for the Nitrate Industry, Christiania, Norway.

Recent Chemical & Metallurgical Patents

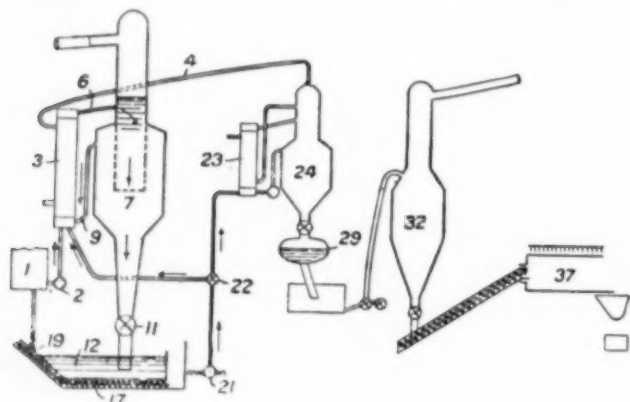
British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Phenol-Aldehyde Condensation Products.—Condensation products are obtained by reaction of phenol or its homologues with formaldehyde in the presence of dilute sulphuric acid in the proportions of 500 volumes of phenol or its homologues, 450 to 550 volumes of 40 per cent formaldehyde, and 2 to 6 per cent by volume relatively to the phenol of dilute sulphuric acid made by mixing 20 volumes of acid of 1.84 sp.gr. with 80 volumes of water the reaction being effected at a temperature of 60 to 80 deg. C. After reaction and removal of water, the product is neutralized—e.g., by milk of lime—and the remaining water is removed by heating *in vacuo*. The product may be finally hardened by heating under pressure. (Br. Pat. 153,494; A. T. BIRKLEY, and F. E. BIRKLEY, Liversedge, Yorkshire. Jan. 19, 1921.)

Devulcanizing Rubber.—Vulcanized rubber is devulcanized by simultaneous treatment with a benzene hydrocarbon, such as 10 per cent of xylol or one of its homologues and a carbocyclic amido compound, such as 2½ per cent of aniline or one of its homologues in the presence of a substance capable of absorbing or combining with sulphur, such as a hydrate of an alkali metal. The treatment is conducted in a digester in which the temperature corresponds with a steam pressure of from 60 to 150 lb. per sq.in. (Br. Pat. 153,646; J. YOUNG and W. W. BENNER, Akron, Ohio. Jan. 19, 1921.)

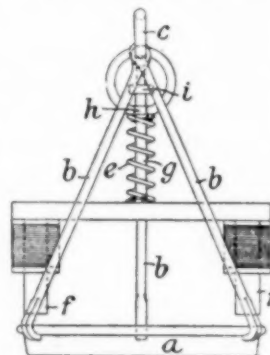
Sodium Nitrate.—Sodium nitrate is obtained from its solutions by first separating a considerable proportion of the sulphates and chlorides present by concentration under an absolute pressure of 11 lb. per sq.in. until the temperature of 90 to 95 deg. C. is reached, and afterward concentrating the liquor at atmospheric or other pressure until the content of chloride (calculated as the sodium salt) is 75 to 80 g. per liter. The concentrated liquor is then cooled for the production of sodium nitrate crystals. The first stage of the concentration is effected in a vacuum evaporator,



consisting of a heater 3 and a separator 7 connected by circulating pipes 6, 9. The crystals of chlorides and sulphates that separate are discharged through a valve 11 into a settling tank 12 from which they are removed by conveyors, 17, 19. The crystals may be washed by liquor from the store tank 1. A pump 2 feeds liquor from the store tank 1 to the heater 3, and a pump 21 returns liquor from the settling tank 12 to the heater. The second stage of the concentration is effected in an intermittently-working evaporator consisting of a heater 23 and a separator 24 operating under a pressure such that the steam generated may be led by a pipe 4 to the heater 3 and used as a heating agent therein. The evaporator 23, 24 is filled by adjust-

ing a valve 22 so as to permit a portion of the liquor from the pump 21 to enter the heater 23. When the liquor has reached the prescribed concentration, the contents of the evaporator 23, 24 are discharged through a filter 29 and are pumped into a chamber 32 maintained under an absolute pressure of 12 to 13 lb. per sq.in., and are cooled to 70 to 75 deg. C. by evaporation under the reduced pressure. The liquor is then transferred to a rotary cooler 37, in which the sodium nitrate separates. (Br. Pat. 153,649; J. L. GRINGIONI, Valparaiso. Jan. 19, 1921.)

Heat-Treatment of Steel.—Steel, after being heated to above the critical temperature, is cooled in proximity to an electro-magnet so that when the critical temperature is reached and the steel regains its magnetic properties, the attraction of the electromagnet may be arranged to give an indication that this temperature has been reached and, if desired, to effect a stoppage of the cooling. In the figure a railway wheel tire *a* is shown suspended in a cooling bath by dogs *b* from a ring *c*; an electro-magnet *f* is suspended above the tire by a spring *e* of such a strength that when the tire is cooled to the critical temperature and becomes magnetic, the magnet *f* moves downward against the spring until the collar *i* on the rod *g* comes into contact with the stop *h*. This movement gives a visual indication or may be arranged to operate a switch to start a crane which lifts the tire from the cooling bath. In a modification the tire is placed on a revolving table and is cooled by a spray. In this case, when the tire becomes magnetic the core of a solenoid is attracted against a spring. The movement of the core may be used as a visual indicator or may operate a device for shutting off the cooling spray. (Br. Pat. 153,756; C. P. SANBERG and J. C. W. HUMPHREY, both of London. Jan. 19, 1921.)



Phenol-Aldehyde Condensation Products.—A thin aqueous liquid condensation product is obtained by reaction of about 1,000 parts of carbolic acid, 1,000 parts of 40 per cent formaldehyde and 50 parts of sodium sulphite, at ordinary temperature for three to four days. The product can be applied directly for impregnating fibrous, etc., materials, which are subsequently dried, and hardened by heating under pressure—for example in the manufacture of friction blocks or pads or stair treads. Water-soluble dyes may be dissolved in the liquid to dye textile materials. (Br. Pat. 153,796; F. SCUDDER and R. PETTIGREW, Manchester. Jan. 19, 1921.)

Solidified Oil Composition.—Tung oil or Chinese wood oil is solidified by the action of haloid salts, particularly chlorides, uniformly disseminated through the oil. To secure this dissemination, the chlorides are first ground up with an indifferent oil, such as resin oil or linseed oil, or dissolved in an anhydrous organic solvent, and the liquid produced mixed with the tung oil. Suitable combinations of salts and solvents are anhydrous ferric chloride in anhydrous acetone, anhydrous aluminum chloride in anhydrous acetone, anhydrous stannic chloride in acetone, anhydrous zinc chloride in amyl acetate or alcohol, and antimony or bismuth chloride in acetone; the use of ferric bromide is also mentioned, and mixtures of various salts may be employed. Fuming chlorides, such as antimony chloride or stannic chloride may be dissolved in benzene or the like and mixed with an indifferent oil and the mixture added to the tung oil, or they may be changed into hydrated chlorides and dissolved in anhydrous solvent and used directly. Filling and coloring matters, fibrous or otherwise, may also be added; a number of suitable and unsuitable substances are mentioned. Rosin gums, ester gums, or other gums easily soluble in oil may be added to the tung oil, as may tung oil fatty acids. Either raw or blown tung oil may be employed, but oil that has been partly polymerized by heat is unsuitable. (Br. Pat. 153,942; B. SCOBEL, New York. Jan. 19, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Preliminary Program, Rochester Meeting, A.C.S.

While the full program for the spring meeting of the American Chemical Society, which will be held in Rochester, N. Y., April 26 to 29, has not been completed as this is written, some features of the program are known at this time. Senator Wadsworth of New York and Representative Longworth of Ohio have promised definitely to address the meeting and have been assigned places on the program of the opening day. On that day also E. C. Franklin will deliver his address on "Ammono Carbonic Acids."

GENERAL ARRANGEMENTS

Tuesday afternoon will be devoted to a general meeting which will be held in the large auditorium of Convention Hall. Alpha Chi Sigma will hold a banquet Tuesday evening at 6:30. Members desiring to attend this banquet should write to I. N. Hultman, Eastman Kodak Co., at their earliest convenience so that reservations can be made. Wednesday and Thursday will be devoted entirely to the presentation and discussion of papers. No excursions or other functions have been planned for these two days, so that there will be absolutely no interference with this part of the program, which is the most important side of the meeting. All divisions and sections can begin their meetings Wednesday morning simultaneously. The place of this meeting is Mechanics Institute and the rooms will be provided with modern projection apparatus and with communicating telephones so that members in other sections can be posted as to what is being done in various other sections. This scheme increases the time devoted to presentation and discussion of papers in all cases by at least one-half day and in many cases by a whole day. Wednesday evening will be given over to general addresses at Convention Hall. Thursday evening has been set aside for a good-fellowship meeting at the Bausch & Lomb Optical Co. Friday and Saturday will be devoted to excursions to the various industrial plants and laboratories in the city.

It is planned to charge a registration fee of \$1. This is in line with the action taken by the council at the fall meeting in Chicago. The money resulting from this registration will be used to defray necessary expenses incurred for arrangements of the meeting.

TENTATIVE DIVISIONAL PROGRAMS

The Division of Industrial and Engineering Chemistry will discuss drying under the guidance of Charles O. Lavett, the chairman of the drying symposium committee.

Division of Physical and Inorganic Chemistry will have a symposium on contact catalysis, over which W. D. Bancroft will preside. Among those who will present papers on that subject are A. F. Benton, R. M. Burns, R. F. Chambers, J. C. Frazer, C. H. Milligan, H. A. Neville, R. N. Pease, F. H. Pollard, E. Emmet Reid, F. L. Simons and H. S. Taylor.

The Division of Rubber Chemistry will discuss among other things a tentative draft of specifications for the analysis of rubber goods.

In view of the critical situation in the dye industry the meeting of the Division of Dye Chemistry is expected to be of unusual interest. The Division of Fertilizer Chemistry is the only division which will not have a group meeting at the Rochester convention.

LOCAL COMMITTEES IN CHARGE OF THE MEETING

The local committees and their chairmen who will be in charge of the meeting are as follows: Executive Committee, Frank W. Lovejoy, honorary chairman; J. Ernest Woodland, chairman; finance, Herbert Eisenhardt; enter-

tainment, Charles F. Hutchinson; registration and information, Harry A. Carpenter; program, Erle M. Billings; transportation, Charles Markus; hotels, Harry L. Gray; excursions, William Earle; arrangements, Donald B. Howe; college and fraternity dinners, and exhibits, Ivan N. Hultman; publicity, Benjamin V. Bush.

The council of the society will meet April 25 at Rochester.

Tariff Prospects

Since tariff legislation affects directly only 14 per cent of the population, while the internal revenue laws apply to practically 100 per cent, there is great political inducement for Congress to take up the revision of taxation ahead of the revision of the tariff. There is a substantial proportion of the membership in each house of Congress, however, that will demand immediate action on the tariff. They point to the chemical industries as affording the most clear-cut cases of the need for immediate protection from the increasing volume of imports.

It is not disputed generally that it would be very difficult at this time to write a permanent tariff measure. It is recognized that information is incomplete with regard to costs of production abroad. There is great uncertainty as to the trend of production costs even in the United States. Foreign exchange adds another element of uncertainty. There is very general support, however, for the proposed re-enactment of a revised Payne-Aldrich bill or of a measure in which the schedules would be more or less arbitrarily arrived at. Either plan, it is argued, would serve as stop-gap measures to apply only until the regular bill can be worked out later in the year.

In the event of the adoption of the Payne-Aldrich schedule to serve until the regular bill can be put into effect, it is pointed out that considerable revision must be had of the rates of duty fixed in that act on chemicals. Since that law was enacted in 1909 a real chemical industry has been developed in the United States. As a result it is contended that many articles now on the free list should bear a duty, while changed conditions require higher schedules on many items.

The duties prescribed by the Payne-Aldrich act on some of the more important chemicals are as follows: Ammonia, liquid anhydrous, 5c. per lb.; essential oils, 25 per cent; coal tar, dyes or colors, 30 per cent; preparations of coal tar, not colors or dyes, 20 per cent; benzene, toluene and naphthalene, free; glycerine, refined, 3c. per lb.; chromium colors, 4½c. per lb.; litharge, 2½c. per lb.; white lead, 3c. per lb.; zinc oxide (dry), 1c. per lb.; zinc chloride, 1c. per lb.; carbon, 20 per cent.

Plans for Mme. Curie's Visit

As a mark of respect to Mme. Curie the formal opening of the Cryogenic Laboratory of the Bureau of Mines will be postponed until the visit of the noted French scientist. Plans are being perfected for other features of Mme. Curie's entertainment, which will include a general reception, at which time all scientists residing in Washington will be given an opportunity to meet the distinguished visitor. The arrangements are in charge of Dr. Vernon Kellogg of the National Research Council.

Buenos Aires Exposition Delayed

The American National Exposition, Inc., which was planning an exposition of United States manufacturers for March 1, 1921, at Buenos Aires, has postponed the enterprise indefinitely due to business conditions in Argentina. The exposition will not be permanently abandoned, and a proposed new date is November and December of this year.

Butyl Alcohol and Acetone From Starch

At the March meeting of the Indiana Section of the American Chemical Society held at Indianapolis M. E. Nasmith, superintendent of the Commercial Solvents Corporation of Terre Haute, Ind., described in considerable detail the process of making acetone and butyl alcohol from starch.

DEVELOPMENT OF THE PROCESS

The fermentation of the hydrolyzed starch is done by an anaerobic spore-forming bacterium, *B. Granulobacter pectinovorum*. This microbe was supplied by Fernbach of the Pasteur Institute to some Englishmen who were interested in producing acetone and higher alcohols for the synthesis of isoprene. At the outbreak of the Great War Weitzman, who had been associated with Fernbach, offered the use of this fermentation process to the British government for the production of acetone needed in cordite manufacture.

When Colonel Gooderham tendered the use of his distillery in Toronto to them the British sent over a chemist and bacteriologist. The difficulties inherent in the adjustment of such a process to a large scale were gradually overcome, but it seemed desirable to have a works nearer the source of raw material, so a distillery was selected in the corn belt at Terre Haute.

When the United States entered the war an adjacent distillery in the same city was adapted to this process, getting well started just before the signing of the armistice. The two governments were in partnership in these two plants. The English sold great quantities of acetone, so there was little demand for that substance after the signing of the armistice, but there has been a real need for higher alcohols for solvent purposes.

This demand encouraged the formation of a syndicate to take over the first plant, which was operated from April, 1920, to the end of that year. At present it is not producing solvents, but many improvements to the process are being worked out.

PREPARING CORN FOR FERMENTATION

Almost any starchy substance may serve as raw material, but there must be sufficient nitrogenous material to give the organism a suitable ration. Of course, corn is the principal substance used and is not hurt even if it has been frostbitten. If the corn is too damp, it must be dried before being stored. The corn is broken in corrugated rollers called "breaks" so that the hulls and bran may be separated from the starch. The germs of the corn are left to supply the organism with necessary nitrogen. The corn meal is gradually fed into ten parts of boiling water with constant stirring. Then the pressure is increased to 70 lb. in 20 min. To overcome the tendency toward foaming of the pasty material when the pressure is released the large pipe leading upward from the cooker is provided with an expansion or blow-off tank to prevent any loss. The cooking brings the starch into a finely divided, more or less hydrolyzed condition which is suitable for fermentation. It also sterilizes the starch very thoroughly. The cooked material is then pumped through 5-in. pipes to the 50,000-gal. fermentation tanks. The greatest care must be exercised in sterilizing everything with which the material comes in contact—a very nice problem with such large units. Also very great care and nice adjustment have to be exercised in controlling the temperature of the mash as it reaches the tanks, since the range of activity of the organism is limited. A slight lowering of temperature will chill the bacteria so that it may take 24 hr. to recover, and again a slight elevation may kill them.

FERMENTATION

The technique of handling and developing the cultures of this bacteria has to be of a very high order. The test-tube cultures are inoculated into 1,200-c.c. Erlenmeyer flasks and after 24 hr. the emulsion breaks, leaving the beer below, in which there is often a slimy streak or "shroud." The Erlenmeyers are taken to the seed room and the culture is introduced into sterile mash in sterilized 5-gal. copper kettles provided with hand stirrers. From

these in due time the inoculated mash is run into the empty sterile fermentation tanks and the mash is next added. The tanks are provided with water seals so that the gases evolved, 60 per cent carbon monoxide to 40 per cent hydrogen by volume, can escape. More or less of the volatile solvents is apt to be lost during this evolution of gas. During 24 hr. 26 tons of carbon monoxide and 1,800 lb. of hydrogen are evolved from a tank, but no attempt is made at present to recover them.

During the fermentation the acidity increases to a maximum, after which it steadily falls off to a constant value. The formation of the solvents begins at this maximum point. It seems probable that there is reduction by the nascent hydrogen of some of the acids formed. If wild ferments have got in, the acidity keeps on rising till the special bacteria are all killed, so that practically no solvents are produced and the batch is wasted.

DISTILLATION

The solvents are removed from the mash by the usual method with suitable heat interchangers. The spent mash contains 3 to 3.5 per cent of solids, which when dried contain 40 to 45 per cent protein, making it valuable for fertilizer or cattle feed. It is an interesting fact that the mash coming out from this still has about double the acidity of the ingoing mash. The water solution of the solvents is pumped into a 20,000-gal. discontinuous still provided with a 30-section rectifying column.

After the removal of the acetone ethyl alcohol is obtained in the next fractions. Then comes the constant composition vapor of waterbutyl alcohol containing 68 per cent of the alcohol. On cooling, this separates into two layers, the upper one containing 88 per cent alcohol to 12 per cent water and the lower one 8 per cent alcohol to 92 per cent water. On separation, the lower layer is run back into distillate from the mash column still, while the upper layer is redistilled in a smaller still. The distillate is always richer in water than the residue, so that finally pure butyl alcohol is left in the still.

From 1 bu. of corn 9.5 to 10 lb. of solvent is obtained. The solvent is a mixture of 60 per cent acetone, 30 per cent ethyl alcohol and about 10 per cent butyl alcohol. There are also traces of amyl alcohols. Butyl alcohol makes a fine solvent for many materials like fine paints and varnishes and rubber. It also is made into esters. The capacity of the plant is 7 tons of solvents a day.

Surplus Brass Sold

Sale of 30,000,000 lb. of brass cartridge cases has been announced by the Director of Sales. The purchasers are: Chase Co., Inc., Waterbury, Conn.; Scovill Mfg. Co., Waterbury, and the Bridgeport Brass Co., Bridgeport, Conn. The price is to be determined by the market price at the time sales are made by these purchasers. The government is to receive 41½ per cent of the average market price for the copper content, plus 19½ per cent of the average market price for prime Western zinc for the month in which deliveries are made. Under this agreement the government will receive a greater return than would have been the case had it accepted the highest bid offered for the outright purchase of the material.

In addition the government has 6,000,000 lb. of cartridge cases still on its hands. This will be held available for sale at any time to brass mills and other consumers under the same general terms.

Oil and Gas Claims in Alberta

It is reported from Edmonton, Alta., that nineteen oil and gas claims, covering 6,000 acres of ground, have been filed with the Dominion government at Fort Smith since the beginning of the year. Practically the entire area in the vicinity of Pine Point, Great Slave Lake, has been staked. The ground has been staked under the old laws, allowing the filing of 320-acre claims, by parties who started for the district before the laws were suspended. The government agent was unable to say what effect the new laws, recently passed but which were made retroactive to the first of the year, will have on these claims.

Need for Fertilizer Grows Rapidly

As a result of the controversy in Congress over the development of Muscle Shoals a great deal of statistical material was gathered in regard to the fertilizer requirements of the country. Among the striking facts brought out was the great increase in the use of fertilizers in sections of the country other than the South. In South Dakota the consumption of fertilizer in 1918 increased 1,150 per cent as compared with the consumption in 1911. During the same period Minnesota's consumption increased 250 per cent. In Oklahoma the increase was 212 per cent, in Wisconsin 200 per cent, in Iowa 150 per cent, in Missouri 122 per cent, in Delaware 216 per cent, in Connecticut 200 per cent, in Oregon 100 per cent.

Wood Pulp Mill at Juneau, Alaska

Wood pulp is now being manufactured in Alaska near Juneau, in the Tongass National Forest. The first mill to be established in this territory has a capacity of twenty tons of pulp a day, but the available hydro-electric power is ample to increase the output to 250 tons. Spruce and hemlock will be ground for newsprint purposes and later the plant will be enlarged so as to manufacture paper.

In response to inquiries from prospective manufacturers Forest Service officials have announced that an area of the Tongass National Forest containing 2,000,000,000 ft. of pulp-making timber would be placed on the market soon.

American Oil Chemists' Society

For a number of years the leading chemists in the cottonseed oil industry have been fraternally associated in the Society of Cotton Products Analysts. This organization primarily concerned itself with perfecting methods of analysis used in the cottonseed crushing and refining industry. It did for the edible oil trade what the Association of Official Agricultural Chemists does for the food industry; the Society for Testing Materials for the paint trade; and the Leather Chemists' Association for the leather and tanning industry. Certain specific qualifications as to membership limited it in numbers to those highly specialized but insured a large amount of important investigational work. The great war drew this country into a large international trade in several of the vegetable oils which became keen competitors of cotton oil. This caused a commensurate widening of the society's interest, with the result that at the annual meeting of the Society in May, 1920, it was reorganized under the name of the American Oil Chemists' Society.

Its aim can be no better expressed than in the words of Article II of its constitution:

Section 1. The object and purpose of the society shall be, first, to unite for fraternal and business purposes all chemists interested in the promotion of the chemistry of fats, oils, waxes and allied industries.

Section 2. To cultivate the ties of friendship that should exist between those who have adopted a similar profession and who enjoy common interests.

Section 3. To encourage the writing of original papers on subjects pertaining to chemical work, to foster and encourage chemical research, to promote a spirit of co-operation and interchange of ideas and to strive for the adoption of uniform methods of analysis to be used by all the members of the society.

Section 4. To exert our influence and efforts toward securing the enactment of state laws safeguarding and protecting the practice and dignity of the chemical profession.

Section 5. To place the profession on the high plane its dignity deserves, and to secure for those engaged in it adequate recognition of their services, in keeping with the years of study required to master it, and the high character of those to whom only its responsibilities should be entrusted.

All persons engaged in chemical work relating to fats, oils, waxes and allied interests are eligible for active membership provided they have had at least five years' chemical training. Its meetings are held once a year, usually in May and in conjunction with the Interstate Cottonseed Crushers'

Association. It regularly publishes its transactions and maintains the chemists' section in the *Cotton Oil Press*, a journal devoted exclusively to the interests of the edible vegetable oil industry.

Its membership, however, is not limited to chemists and technologists engaged exclusively in the edible oil trade, but includes also those interested in its so-called industrial or technical aspects. Although the entire vegetable oil industry is founded upon more or less similar practice in obtaining the oil, the unified character of the industry ceases at that point and then splits up into several rather well-defined branches, namely those of edible oil, paint, soap, vulcanization, sulphonation, etc. The oil industry is too elastic to permit any oil to be pocketed; therefore, no oil chemist should confine his interest exclusively to his given line. Since most of the oils dealt with are industrially more or less interchangeable, their chemical control and technological development can be properly fostered only by sympathetic and intimate contacts between science and industry, such as are furnished by the American Oil Chemists' Society.

Chemical Imports and Exports

Imports of chemicals, drugs, dyes and medicines continued to increase during January, according to figures which just have become available at the Bureau of Foreign and Domestic Commerce. The increase applies only to chemicals on the free list. In January, 1921, the value of chemicals imported on which no duty was charged was \$8,994,118. The value of the dutiable chemicals imported was \$3,237,732.

Exports of chemicals during January of 1921 were valued at \$9,420,043. This is a decrease from \$11,367,979, which was the value of exports in January of 1920.

The imports of colors and dyes slumped decidedly in January of 1921, as compared with the corresponding month of 1920. In January, 1921, the imports amounted to 270,833 lb. In January of 1920 the aggregate of the imports was 539,144 lb. On coal-tar products as a whole, however, there was an increase in January of 1921. In that month the value of all coal-tar products was \$1,495,375. This compares with \$1,229,116, the total value of coal-tar products imported in January of 1920.

The recession in imports of gums continued during January. The total imports during January of 1921 was 7,518,576 lb. In January of 1920 the imports were 12,328,990 lb. Imports of other chemicals and drugs which do not move in such large quantities are shown by the following:

	January	
	1920	1921
Ammonia, muriate of, lb.	599,979	41,727
Arsenic, lb.	569,562	740,976
Indigo:		
Natural, lb.	13,413	6,063
Synthetic, lb.	18,001	.....
Glycerine, lb.	658,630	111,701
Iodine, lb.	100	37,203
Magnesite, tons	3,613	4,366

Acids were exported during January, 1921, in somewhat less volume than in the corresponding month of 1920. In January, 1921, the exports of carbolic, nitric, picric, sulphuric and other acids were valued at \$315,562. This compares with \$490,353, the value of the exports in January, 1920. The value of dyes and dyestuffs exported in January, 1921, amounted to \$1,335,531. In January, 1920, the figure was \$1,449,153. Extracts for tanning exported in January, 1921, were valued at \$116,445, which is a decided decrease from \$500,276, the value of the exports in January of 1920. The value of the exports of the various salts of soda in January, 1921, was \$755,471. The exports in January, 1920, were valued at nearly double that sum, or \$1,361,316. Exports of chemicals which moved in less volume are shown as follows:

	January	
	1920	1921
Alcohol, wood, gal.	126,673	49,685
Calcium carbide, lb.	736,959	2,131,432
Sulphur, tons	51,019	30,222

British Columbia Industrial Notes

A loan of \$25,000, under the provincial industrial act, has been granted by the government to the Douglas Fir Turpentine Co., to assist in the development of the resinous product industry. The company's plant is situated on False Bay, Vancouver, and the company is collecting resins by a special process from Douglas fir trees, which abound in this vicinity. Turpentine, flotation oils, balsam, burgundy pitch and venice turpentine are manufactured from the material collected. It is claimed that by the method of tapping adopted the trees are not injured, but, on the other hand, the growth is stimulated—a statement that has been corroborated by the provincial forestry experts.

The Forestry Branch of the Department of Lands has published the following outputs of pulp and paper in British Columbia for last year:

	1919 Tons	1920 Tons
Sulphite pulp	80,047	92,229
Sulphate pulp	3,473	16,380
Ground wood	99,769	108,665
Newsprint	123,607	136,832
Wrapping paper	7,202	9,792

The Consolidated Mining & Smelting Co. has shipped a large consignment of refined copper on the Empress of Russia, which sailed recently for the Orient from Vancouver.

New Arsenic Plant at Toulon, Nev.

The new arsenic plant which recently was erected at Toulon, Nev., is intended to supply from domestic sources the arsenic used in insecticides by the citrus fruit industry of the Southwest. It is stated that the bulk of the arsenic used for that purpose now is being imported from Japan.

The new plant will draw its supplies of arsenic from two extensive deposits located at Battle Mountain and Beowawe, nearby points in Nevada.

A very determined effort is being made by those interested in the development of these Nevada deposits to get an import duty on arsenic. The Committee on Ways and Means has been told that the Japanese have resorted to various methods to prevent the amount of arsenic imports from becoming known. During 1920 the official figures show imports of only 8,160,000 lb. Since large quantities of arsenic are said to have come in under other designations, it is claimed that the real imports are much higher. It also is asserted that the product from the Nevada plant will not enter into competition with other domestically produced arsenic in the territories now supplied by domestic producers, particularly those in Montana and Washington.

National Research Council Establishes Research Information Service

The National Research Council has recently established a research information service which will be a clearing house for information about the mathematical, physiological and biological sciences and their applications in industry, commerce and education. A technical staff assures an intelligent interpretation of requests and skillful search for the information desired.

Ultimately it is planned to have a specialist on the staff to represent each major division of science and technology, as well as specialists on the relation of science to industrial, commercial and educational problems.

No charge is made for replies to inquiries which do not necessitate a special search. Requests for data which can be secured only by expending considerable time are acknowledged with an estimate of the necessary cost of assembling what is desired.

Further information may be secured from the Research Information Service of the National Research Council, Washington, D. C.

Aluminum Production in 1920

The value of primary aluminum produced in the United States in 1920, according to reports received by the U. S. Geological Survey, was \$41,375,000, as compared with \$38,558,000 in 1919. The market prices throughout the year have been nearly constant, ranging from 32c. to 33c. per lb.

Book Reviews

LEHRBUCH DER EISEN UND STAHLGIESSEREI (Text Book on Iron and Steel Founding). By *Prof. B. Osann*. Leipzig: Wilhelm Engelmann, 1920. Price, 42 marks in paper cover, 52 marks in cloth both plus export tax, at present 175 per cent.

Every book written by Prof. Osann is characterized by thoroughness and technical value. This new (fourth) edition is an amplification of the original work, 170 added pages bringing the information contained up to date. The thoroughness displayed by the author accounts for the retention of much obsolete matter, from which, however, one who wishes can learn what not to do. The effect of American foundry literature is plainly manifest throughout the book, and indeed this is generously acknowledged by the author.

After a general classification of iron products, a few pages are given to the technology of combustion and refractory linings. The history of cast iron is given in very condensed form, which is rather astonishing in a German book. Pig iron, "direct" metal from the blast furnace for castings, come next and then a short comparison of melting methods. The crucible melting process and its derivatives follow, and then we have twenty pages on the air furnace. Much of value is given in this connection, particularly the calculation of furnace dimensions—of which little has been published heretofore. Since the steel casting is involved, the open-hearth and converter processes are explained.

Ninety pages are devoted to cupola practice to bring the subject as up to date in Germany as we know it here. The greater familiarity of the author with the blast furnace is plainly evident, as he misses some of the important requirements of cupola charging, and dismisses the oil-fired cupola with two lines.

The chemistry and physics of cast iron are gone into quite thoroughly. Unfortunately, the information is quite scattered, but none the less faithfully recorded somewhere in the book. The action of the elements in iron castings, a list of recommended compositions for castings, the varieties of pig and scrap used in mixture-making, ferro-alloy additions, and the effect of remelting are taken up in succession.

Next come the methods of testing cast iron and castings for strength, contraction, shrinkage, hardness, casting strains, chill, etc. The art of molding follows, with fifty pages of material on molding machines, after which the several methods of molding are gone into thoroughly, with many examples. Permanent molds, foundry rigging, flasks, etc., are described, and special chapters on pipe making, car wheels, and other standard branches of the art follow. Pouring methods with the recent advances in centrifugal pouring, mold drying methods, core-making, molding sand preparation—in which Europe is somewhat ahead of us—are given. The disposition of foundry refuse is also taken up specially.

The steel casting comes next, with twenty-seven pages; and "malleable" follows with twenty more. Cleaning methods from hand brushing to the sand blast are gone into. The "burning on" of defective work, traveling and other cranes follow, and the book is completed by chapters on the foundry lay-out, foundry costs, and finally a chapter on the metallography of cast iron.

Perhaps the most serious criticism of this otherwise admirable book can be directed against the sequence of the material contained. One has to consult the not too copious index to find a lot of things which seem to be thrown in at random. None the less most of the information required for an operating foundry is there. The book deserves to be added to the working library of every foundryman and engineer able to handle the German language, as it is unquestionably the standard foundry book for Continental Europe.

RICHARD MOLDENKE.

Personal

Dr. C. L. ALSBERG has resigned as chief of the Bureau of Chemistry, Department of Agriculture, to accept the directorship of the food research institute of Leland Stanford University, which is founded by the Carnegie Corporation grant. Dr. Alsberg's resignation will take effect in the early summer, as soon as his successor can be obtained.

C. K. CALVERT has resigned as chemist and bacteriologist with the Indianapolis Water Co. His place has been taken by Norman D. Doane of Meadville, Pa.

CHRISTIAN CHRISTENSEN of Washington, D. C., has opened a laboratory and office in the Transportation Building, Indianapolis, Ind., for consulting work in engineering problems of a chemical nature.

Dr. W. R. CLEMENTS, head physician at the Repauno plant of E. I. du Pont de Nemours & Co., gave an interesting address recently before the members of the Delaware Safety Council, Wilmington, on the subject of "General Industrial Health."

H. A. DEFRIES has resigned his position as vice-president of Hamilton & Hansell, Inc., New York City, and has opened offices at 15 Park Row, New York City, as a consulting engineer and metallurgist, specializing in electric-furnace construction and electrometallurgy.

A. M. FAIRLIE of Atlanta, Ga., was in New York City recently on business.

HAROLD A. HARTT, who recently was graduated from Cornell University, is now research chemist in the moving picture department of the research laboratory of the Eastman Kodak Co., Rochester, N. Y.

ELMER F. JOURDAIN, of the U. S. Industrial Alcohol Co., addressed the Chicago Chemists Club, March 1, on the restrictions covering the use of alcohol in laboratories.

Dr. A. E. KOENIG resigned as assistant professor of chemistry at the University of Wisconsin to become associate professor of chemistry at the State School of Chemistry at the State School of Mines, Butte, Mont.

S. C. LOO, technical adviser to the Leather and Wool Commission and the Board of Communication, Peking, China, is touring the United States gathering information on apparatus for chemical plants. His address in the United States is care of the Chinese Legation, Washington, D. C.

JESSE P. LYMAN, Boston, Mass., has been elected president of the American Glue Co., to succeed King Upton, who died recently at his home at Marblehead. Mr. Lyman was president of the company from 1905 to 1918, resigning to be relieved of the duties of the office. He has been treasurer since 1907.

F. B. ORTMAN, who has been for some time associated with the staff of the Northwestern Terra Cotta Co., Chicago, Ill., has resigned to become vice-president and general manager of the Tropico Potteries, Inc., Los Angeles, Cal.

ARTHUR E. RICE has been elected president of the Pennsylvania Salt Co., Philadelphia, Pa., succeeding Joseph Moore, Jr., who died recently. Mr. Rice has recently been vice-president of the company, and treasurer previous to that. Edward Armstrong, for many years superintendent of the company's plant at Pittsburgh, has been elected vice-president, succeeding Mr. Rice.

Major ALFRED L. ROCKWOOD and Captain ADRIAN ST. JOHN, of the Chemical Warfare Service, have been ordered to Fort Leavenworth for duty as student officers at the School of the Line for the year 1921-1922.

Dr. C. B. THWING, president of the Thwing Instrument Co., is taking a much-needed rest in Florida for a month as the guest of his brother, F. H. Thwing, at Orlando.

F. B. TOUGH, petroleum technologist of the Bureau of Mines, has been made supervisor of oil and gas operations, with headquarters in the Custom House Building, Denver, Col.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 21, 1921.

The chemical market during the past week showed a more or less potential buying power. This, together with reduced stocks, imparted greater confidence in the trade outlook. There seemed to be more confidence, however, than actual performance, but all the indications pointed to a slow and steady rehabilitation in the industry.

It is generally admitted that the foreign situation of today is exceedingly problematical and might well cause anxiety among buyers who have taken advantage of the low prices named. Yet the actual new buying for the period under review could not be termed active and the inquiries received seemed to have a feeling out character to ascertain the status of the market here. Several prominent interests close to the pulse of domestic trading stated that during the latter part of the week more inquiries were received than during the entire month of February. Developments are being keenly awaited and sellers are expecting some shift of operations from foreign to domestic chemicals. Another feature of foreign chemicals has materialized in sales of English *soda ash*. Some small-lot business has been placed in this chemical at \$1.90 per 100 lb. N. Y., and it is understood that orders can be taken at this figure for prompt shipment from England. Imported *prussiate of soda* has weakened the market considerably for that chemical. The return of large quantities of American *caustic potash* from foreign ports has kept prices uncertain, while various grades of *chlorate of potash* have been on the market at prices well below the views of domestic producers.

DEMAND FROM INDUSTRIAL PLANTS IRREGULAR

Textile mills have bought moderately, although the general disposition of all Eastern mills is to purchase conservatively. Soapmakers seem to be showing more interest and prominent dealers among rubber manufacturers stated that they have noted a perceptible improvement in the call for miscellaneous chemicals. Tanneries are not interested in any marked degree. The demand from paint and glass manufacturers is quite irregular and without any tint of real snap. The closing down of some large chemical producing plants on account of the low prevailing prices is indicative at least that the reaction of values has gone its limit and that crude materials have got to decrease if any further downward revisions are to be expected in finished products.

On account of the recent slump in alcohol prices first hands have reduced *formaldehyde* to 15½@16c. per lb. *Acetic acid* is somewhat lower. *Oxalic acid* closed higher under an improved inquiry. *Sulphuric acid* consumers seemed to be more attentive of late and producers have noticed this improvement with revisions in prices. *Caustic soda*, *bichromate of soda* and *soda ash* displayed a slightly easier tendency, although buyers have experienced some difficulty in getting any round lots. A fair amount of *bleach* business was placed at 2½c. per lb. f.o.b. works for prompt and forward shipments to papermakers. Export business continued slow, although conditions appear to be crystallizing in a more favorable light for improvement. The strong recovery in exchange rates during the past week was a satisfactory development.

GENERAL CHEMICALS

Leading producers of *copper sulphate* report a slightly easier market for standard brands, 99 per cent, large crystals. Carlots are obtainable at 5½c. per lb., while the small crystals, 98½-99 per cent, can be purchased at 5½c. per lb. A fairly active inquiry has reached the market from several European centers along the Mediterranean coast and also from France. It seems that German competition is keen enough to restrict any real business, as the price named by Germany c.i.f. those ports is about the cost of

production in America. The demand from domestic consumers has remained quiet. Buyers are hesitating because they believe that the market will go lower. Textile mills are buying sparingly and the movement to dyestuffs plants is far below that of last year. Makers of insecticides are also hesitating, awaiting any new revision in prices. Isolated lots of *prussiate of soda* sold as low as 13c. per lb. during the week, but most sellers were not eager to shade 13½c. An irregular call from the consuming trade has been experienced and transactions as a rule were confined to small tonnage lots. Solid *caustic soda* was quoted at \$3.60@3.75 per 100 lb., the inside figure being a domestic price and the outside an export figure. It is understood that quite a number of sales were made at out-of-town points by dealers for nearby shipments at the inside quotation. Outside brands can be purchased below these prices. Resale lots of standard brands are quite difficult to be found and the market showed a firmer tendency. Producers' prices remained unchanged at 3½c. per lb., basis 60 per cent, f.o.b. works for prompt and future shipments.

There are sellers of small lots of *bichromate of potash* at 13@13½c. per lb. Reports were current that scattered lots have occasionally been sold a shade under the inside price. The demand is quiet and there is no special feature to trading. Large consumers are receiving their supplies through regular contract channels. Resale lots of *soda ash* in single bags were offered by dealers at \$1.95@2.05 per 100 lb. Limited quantities of barrels were quoted at 2½c. per lb. Imported ash is obtainable at \$1.90 per 100 lb. Sales were not heavy during the week, but the tendency of prices continued steady. Anxiety over receiving shipments from abroad has strengthened the inquiry for *oxalic acid* in the local market and prices at the close of the week were considerably higher, with sellers naming 17½@20c. per lb. Some prominent dealers were naming prices all the way up to 25c. per lb. for prime domestic material. Resale *formaldehyde* is on the market at 16@16½c. per lb., but producers have lowered their price to a level which now offers keen competition. The minimum price now heard in first-hand quarters for large lots is 15½c. and 16c. per lb. and upward for small quantities. Trading in *bichromate of soda* during the past week has not shown much improvement. Limited quantities of resale material have been taken by buyers at prices ranging from 7½@8½c. per lb. Sellers in most quarters have not been inclined to shade 8c., but these holders have met with strong competition and the market has shown an irregular tendency. Futures have been practically neglected and the market was in a nominal condition.

COAL-TAR PRODUCTS

Improvement, while not general, has certainly made its appearance in various quarters of the coal-tar products market, which of course is traceable to and accounted for by the more extensive operations in the allied trades. Retail prices on many commodities have reached a level that is attracting the ultimate consumer, and large quantities of the accumulated stocks are being taken off the market. This seems to be particularly the case along the line of shoes, clothing and fabrics. The textile mills have increased their operations and many plants report their output substantially enlarged. An indication of the feeling as to the ultimate trend of this market is illustrated to some extent by the fact that only recently there have been some new concerns entering the manufacturing end of intermediates and dyestuffs. These factors have a good grip on the prevailing conditions and report some regular business of an encouraging nature. Sellers, including producers and dealers, are now handling what business comes their way and are going as far as they can without having to take any loss to meet buyers' views. The crude market is holding steady and considering the curtailed production and the lack of any outlook for a decrease in costs, firmness is looked for in this end of the industry. Intermediates have deviated very little during the week. Any firm orders were met with considerable shading in all quarters.

Producers report a fairly steady demand for supplies of *para-amidophenol*. Sellers seem to be in a good position on available material and quote the market at \$1.90@2 per

lb. for the base and \$2.10@2.20 for the HCl material. Trading in the market for *diethylaniline* continued along quiet lines with the demand routine for small lots. Supplies are available in fair volume on a basis of \$1.20@1.30 per lb. Consumers showed an added interest in *para-phenylenediamine* during the week and prices have held steady at \$1.90@2 per lb. During the year 1918, 215,148 lb., valued at \$3.68 per lb., was produced, while in 1919, 234,332 lb., valued at \$2.43 per lb., was manufactured. Trading in *orthonitrophenol* was reported in some quarters as fairly steady, but the lots were of a small nature. Sales are heard on a basis of 75c. per lb., but shading is possible on a firm bid. There was nothing in the way of buying to attract attention in the *nitro-benzene* market, as only a small routine business was reported in some quarters. Prices remained unchanged at 12@14c. per lb.

While the market remained easy on *aniline oil* supplies, there seems to be little pressure to sell and prices in first-hand quarters are fairly steady at 22@27c. per lb. There is a moderate amount of business reported in some directions and shading of the above prices is thought possible in some second-hand quarters on a firm order. Reports of producers of *benzene* show a fairly active market with domestic consumers quite interested and taking regular supplies, while the foreign demand is growing. Producers are steady in their views and quote on a basis of 30@36c. per gal. for the pure material and 28@32c. per gal. for the 90 per cent grade. The demand for *toluene* has remained dull and little has occurred to stimulate trading. Producers have stocks in fair volume, but production at plants has been somewhat curtailed in view of the light demand. Prices are held steady at 30@36c. per gal.

WAXES

Trading in crude *beeswax* was along routine lines, but prices were mainly on a fairly even basis throughout the week. African crude was offered at 17@20c. per lb. Brazilian was held at 25@27c. per lb. Refined wax was moving slowly at 27@32c. per lb. Leading importers report the market for *carnauba wax* unchanged, with trading comparatively quiet. Flora was available at 68@70c. per lb. and No. 2 North Country at 30@32c. per lb. The demand for *Japan wax* was limited, but with no apparent selling pressure in evidence, due to the fact that stocks on hand are small, prices were maintained at 19@20c. per lb.

With the market for crude oil moving down and export trade showing no improvement the market for *paraffine wax* closed weak with prices irregular. Scale wax, 122-124 melting point, was offered at 2½c. per lb. Fully refined, 130-132 melting point, was quoted on the basis of 5½@6c. per lb.

The Iron and Steel Market

PITTSBURGH, March 18, 1921.

Production of steel has been still lower in the past week, the Steel Corporation's production this week being hardly over 45 per cent of capacity, against about 60 per cent last week, while independent mill operations seem to be considerably below the 25 per cent rate the independents were being credited with a fortnight ago.

For weeks past the volume of buying, including both fresh purchases and specifications against contracts, has been far below the production. The rate of buying appears to have turned upward in the past week or ten days, though only very slightly. Production on the whole continues to decline rather sharply, but the two lines are still far apart.

The case is simply that the independents have been unable to maintain their rate of production even by price cutting, while the disturbance in market values has caused Steel Corporation customers to call for a greater reduction in shipments to them than would otherwise have been the case. The Steel Corporation's shipments promise to continue declining unless consumption increases very materially, since many of the corporation's customers have stocks, accumulated recently when the shipments were in excess of consumption.

Improvement in demand is noticed particularly in the case of standard steel pipe and black and galvanized sheets. The increase in volume is slight and is noticeable only be-

cause the volume formerly was so small. There is no reason to suppose that there is reflected anything like the beginning of a general buying movement. Rather there is a reaction from a buying rate that was too low for permanence, for consumption cannot possibly cease entirely. To a slight extent there is probably reflected the advance in the season, but the full influence of the advent of spring is not yet seen.

PRICES

Bars are still quotable at 2c. and shapes and plates at 2.10c., there being no quotable change in two or three weeks, but perhaps there is a difference in that single carloads can now be bought at the prices just named. Concessions for larger tonnages with attractive specifications are possible, as formerly. The record low on plates seems to be 1.90c., made on a particularly desirable order.

Sheets are definitely lower than a week ago, single carloads being obtainable at 3.85c. for black and 5c. for galvanized, prices that ten days ago were possible only on fair sized lots, say 500 tons.

Hoops are obtainable more freely at 2.80c., against 3.05c. in the Industrial Board schedule. Cold-rolled strips can be done at 5.65c., the usual asking price being 6c., while the nominal price is 5.25c.

Steel prices are really of no particular moment at this time. There is no price issue between buyer and seller, and no reduction possible that would bring out any considerable volume of buying. Many buyers prefer to see prices maintained, as they have stocks of steel or of their manufactured goods and are more interested in disposing of these stocks than in making fresh purchases. The situation is of course one that will liquidate itself in time, and then price will be a very interesting subject to all buyers.

The Steel Corporation continues to maintain the Industrial Board prices it adhered to in 1920 when all independents advanced to higher levels. There is no prospect of the corporation taking any action in the very near future. Indications are that the corporation will probably change its system of mill and furnace operation in the course of a month or so by eliminating the 12-hour workday, but whether the change will be made in such manner as to decrease the wage cost of producing steel is merely matter for conjecture, hence it is not necessarily to be assumed that the corporation will reduce its prices at that time. Some of the corporation's customers have expressed their full approval of the corporation's policy of maintaining prices at this time and there is no evidence that buyers in general are eager for a reduction. It is a situation that must be allowed to work itself out.

Steel-producing capacity is so large, and the prospects for reducing production costs so uncertain, that if producers became careless in the matter of quoting prices the market might descend to a level that would mean loss for an indefinite period, as it would be extremely difficult to get prices up again without a demand representing approximately the full capacity, and such demand is not to be seen even in dim prospect. There has never been a demand for steel equal to the present capacity. Production during the first nine months of 1920, when demand seemed very heavy, was only 80 per cent of capacity, there being restriction by rail transportation and other conditions.

PIG IRON AND COKE

Merchant production of pig iron is extremely light, yet not all the iron produced is being shipped. Foundries appear in many cases to have fairly large stocks. It is only occasionally that there is any inquiry in the open market. The market is largely nominal at \$27 for bessemer, \$25 for basic and \$26 for foundry, f.o.b. valley furnaces. On a round tonnage lower prices could probably be done. Price is not entirely a matter of cost, since there are stocks that producers would be glad to work off, while some furnaces would probably be willing to accept orders for pig iron still to be made at less than present cost, in hope of being able to reduce cost during operation. Several Connellsville coke producers have reduced wages, and this may account for offerings of spot furnace coke at \$4.25, against \$4.50 recently the minimum.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		\$0.55 - \$0.60
Acetone	lb.	\$0.13 - \$0.13	13 - 14
Acid, acetic, 28 per cent	100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 50 per cent	100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys	100 lbs.	9.00 - 9.50	10.00 - 10.50
Boric, crystals	lb.	14 - 15	15 - 16
Boric, powder	lb.	15 - 16	17 - 18
Citric	lb.		46 - 48
Hydrochloric	100 lb.	1.75 - 2.00	2.10 - 2.25
Hydrofluoric, 52 per cent	lb.	15 - 16	16 - 18
Lactic, 44 per cent tech	lb.	10 - 11	11 - 12
Lactic, 22 per cent tech	lb.	04 - 05	06 - 07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)	lb.		
Nitric, 40 deg	lb.	06 - 07	07 - 07½
Nitric, 42 deg	lb.	07 - 08	08 - 08½
Oxalic, crystals	lb.	17 - 18	19 - 20
Phosphoric, Ortho, 50 per cent solution lb.	lb.	15 - 15½	16 - 16½
Picric	lb.	30 - 32	35 - 40
Picogallic, resublimed	lb.		2.30 - 2.40
Sulphuric, 60 deg, tank cars	ton		15.00 - 16.00
Sulphuric, 60 deg, drums	ton		
Sulphuric, 66 deg, tank cars	ton	19.00 - 20.00	
Sulphuric, 66 deg, drums	ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg, carboys	ton		
Sulphuric, fuming, 20 per cent (oleum)	ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum)	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum)	ton	32.00 - 35.00	40.00 - 45.00
Tannic, U. S. P.	lb.		1.15 - 1.25
Tannic (tech.)	lb.	45 - 47	48 - 50
Tartaric, crystals	lb.		34 - 38
Tungstic, per lb. of WO	lb.		1.30 - 1.40
Alcohol, Ethyl	gal.		4.75 - 5.00
Alcohol, Methyl (see methanol)	gal.		
Alcohol, denatured, 188 proof	gal.		44 - 50
Alcohol, denatured, 190 proof	gal.		51 - 54
Alum, ammonia lump	lb.	04 - 04½	04 - 05
Alum, potash lump	lb.	05 - 06	06 - 07
Alum, chrome lump	lb.	13 - 13½	14 - 14½
Aluminum sulphate, commercial	lb.	02 - 02½	02 - 03
Aluminum sulphate, iron free	lb.	03 - 03½	03 - 03½
Aqua ammonia, 26 deg, drums (750 lb.)	lb.	07 - 07½	07 - 08
Ammonia, anhydrous, cyl (100-150 lb.)	lb.	30 - 32	33 - 35
Ammonium carbonate, powder	lb.	10 - 11	11 - 12
Ammonium chloride, granular (white)	lb.	07 - 08	08 - 08½
Ammonium chloride, granular (gray salt)	lb.	08 - 08½	09 - 09½
Ammonium nitrate	lb.	08 - 08½	09 - 10
Ammonium sulphate	100 lb.	2.90 - 3.00	3.10 - 3.20
Amylacetate	gal.		4.00 - 4.25
Arsenic oxide, (white arsenic) powdered lb.	lb.	09 - 09½	10 - 10½
Arsenic, sulphide, powdered (red arsenic) lb.	lb.	14 - 14½	15 - 15½
Barium chloride	ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide)	lb.	19 - 20	21 - 22
Barium nitrate	lb.	10 - 10½	10 - 11
Barium sulphate (precip.) (blanc fixe) lb.	lb.	04 - 05	05 - 06
Bleaching powder (see calc. hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Bromine (see sulphur, roll)			
Bromine	lb.	40 - 41	42 - 45
Calcium acetate	100 lbs.	1.60 - 2.00	
Calcium carbide	lb.	04 - 04½	04 - 05
Calcium chloride, fused, lump	ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated	lb.	01 - 01½	02 - 02½
Calcium hypochlorite (bleach'g powder) lb.	lb.	02 - 02½	03 - 03½
Calcium peroxide	lb.		1.25 - 1.50
Calcium phosphate, tribasic	lb.		15 - 16
Camphor	lb.		72 - 75
Carbon bisulphide	lb.	08 - 08½	09 - 09½
Carbon tetrachloride, drums	lb.	10 - 10½	11 - 12
Carbonyl chloride (phosgene)	lb.		75 - 1.00
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	08 - 09	09 - 10
Chloroform	lb.		38 - 40
Cobalt oxide	lb.		3.00 - 3.10
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	22 - 23	24 - 25
Copper cyanide	lb.		60 - 62
Copper sulphate, crystals	lb.	05 - 05½	06 - 06½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.		1.00 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)			
Formaldehyde, 40 per cent	lb.	15 - 16	16 - 16½
Fusel oil, ref.	gal.		4.00 - 4.50
Fusel oil, crude	gal.		2.50 - 2.75
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra	lb.		19 - 20
Iodine, resublimed	lb.		3.75 - 3.85
Iron oxide, red	lb.		10 - 20
Iron sulphate (copperas)	100 lb.	1.15 - 1.25	1.50 - 1.75
Lead acetate	lb.		14 - 16
Lead arsenate	lb.	11 - 12	12 - 13
Lead nitrate	lb.		15 - 20
Litharge	lb.	08 - 09	09 - 10
Lithium carbonate	lb.		1.25 - 1.50
Magnesium carbonate, technical	lb.	10 - 11	11 - 12
Magnesium sulphate, U. S. P.	100 lb.	2.25 - 2.75	
Magnesium sulphate, commercial	100 lb.		1.70 - 2.00
Methanol, 95%	gal.		88 - 92
Methanol, Col mbian spirits	gal.		1.20 - 1.25
Nickel salt, double	lb.		12 - 12½
Nickel salt, single	lb.		13 - 13½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	45 - 46	47 - 50
Phosphorus, yellow	lb.		35 - 37
Potassium bichromate	lb.	12 - 13	13 - 14

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$ 30 — \$ 35	\$ 30 — \$ 35
Potassium bromide, granular..... lb.	20 — 40	20 — 40
Potassium carbonate, U. S. P..... lb.	35 — 40	45 — 50
Potassium carbonate, crude..... lb.	08 — 08½	09 — 10
Potassium chlorate, crystals..... lb.	08 — 10	11 — 15
Potassium cyanide..... lb.	—	40 — 45
Potassium hydroxide (caustic potash)..... lb.	10 — 11	12 — 13
Potassium nitrate..... ton	60.00 — 70.00	—
Potassium iodide..... lb.	—	2.75 — 3.00
Potassium nitrate..... lb.	09½ — 09½	10 — 12½
Potassium permanganate..... lb.	45 — 46	48 — 50
Potassium prussiate, red..... lb.	50 — 52	53 — 55
Potassium prussiate, yellow..... lb.	25 — 26	27 — 28
Potassium sulphate (powdered)..... per unit	—	2.25
Rochelle salts (see sodium potas. tartrate)	—	—
Sal ammoniac (see ammonium chloride)	—	—
Salt soda (see sodium carbonate)	—	—
Salt cake..... ton	—	30.00 — 33.00
Silver cyanide..... oz.	—	1.30 — 1.35
Silver nitrate..... oz.	—	38 — 40
Soda ash, light..... 100 lb.	1.95 — 2.10	2.15 — 2.40
Soda ash, dense..... 100 lb.	2.20 — 2.30	2.40 — 2.60
Sodium acetate..... lb.	05½ — 05½	06 — 06½
Sodium bicarbonate..... 100 lb.	2.60 — 2.75	3.00 — 3.25
Sodium bichromate..... lb.	08 — 08½	08½ — 08½
Sodium bisulphate (nitre cake)..... ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphate powdered, U. S. P..... lb.	05½ — 05½	06 — 06½
Sodium borate (borax)..... lb.	07½ — 08	08½ — 08½
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.25 — 2.50
Sodium chloride..... lb.	10 — 10½	10½ — 11
Sodium cyanide, 96-98 per cent..... lb.	20 — 22	23 — 30
Sodium fluoride..... lb.	13 — 13½	14 — 14½
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 — 3.70	3.80 — 4.00
Sodium hyposulphate..... lb.	—	03½ — 04
Sodium nitrate..... 100 lb.	2.75 — 2.85	2.85 — 3.00
Sodium nitrite..... lb.	06 — 06½	06½ — 07
Sodium peroxide..... lb.	30 — 31	32 — 34
Sodium phosphate, dibasic..... lb.	04½ — 04½	05 — 05½
Sodium potassium tartrate (Rochelle salts)..... lb.	14 — 14½	14½ — 14½
Sodium prussiate, yellow..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (40 deg.)..... lb.	03 — 03½	03½ — 03½
Sodium silicate, solution (60 deg.)..... lb.	1.75 — 2.00	2.25 — 2.50
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	05 — 05½	05½ — 06
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	04 — 04½	04½ — 05
Sodium sulphite, crystals..... lb.	16 — 16½	16½ — 17
Sodium nitrate, powdered..... lb.	07 — 07½	07½ — 08
Sulphur chloride, red..... ton	16.00 — 20.00	—
Sulphur, crude..... lb.	08 — 08½	08½ — 09
Sulphur dioxide, liquid, cylinders..... 100 lb.	—	2.25 — 3.10
Sulphur (sublimed), flour..... 100 lb.	—	2.00 — 2.75
Sulphur, roll (brimstone)..... lb.	18 — 19	20 — 22
Tin bichloride, 50 per cent..... lb.	—	40 — 42
Tin oxide..... lb.	16 — 18	19 — 20
Zinc carbonate, precipitate..... lb.	45 — 49	50 — 60
Zinc chloride, gran..... lb.	12 — 13	13½ — 14
Zinc cyanide..... lb.	09 — 09½	09½ — 10
Zinc dust..... lb.	03½ — 03½	04 — 05
Zinc oxide, XX..... lb.	—	—
Zinc sulphate..... lb.	—	—

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	38 — 40
Aniline oil, drums extra..... lb.	22 — 26
Aniline salts..... lb.	28 — 32
Anthracene, 80% in drums (100 lb.)..... lb.	75 — 1.00
Benzaldehyde U. S. P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	95 — 1.05
Benzidine sulphate..... lb.	80 — 90
Benzic acid, U. S. P..... lb.	65 — 70
Benzic acid, U. S. P..... lb.	65 — 70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	30 — 35
Benzene, 90% in drums (100 gal.)..... gal.	28 — 32
Benzyl chloride, 95-97% refined..... lb.	30 — 35
Benzyl chloride, tech..... lb.	25 — 30
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	70 — 75
Beta-naphthol, tech..... lb.	35 — 45
Beta-naphthylamine, sublimed..... lb.	27 — 30
Cresol, U. S. P., in drums (100 lb.)..... lb.	2.25 — 2.40
Ortho-cresol, in drums (100 lb.)..... lb.	16 — 18
Cresylic acid, 97-99%, straw color, in drums..... gal.	23 — 25
Cresylic acid, 75-97%, dark, in drums..... gal.	90 — 95
Cresylic acid, 50%, first quality, drums..... gal.	85 — 90
Dichlorobenzene..... lb.	55 — 60
Diethylaniline..... lb.	06 — 09
Dimethylaniline..... lb.	1.20 — 1.30
Dinitrobenzene..... lb.	55 — 65
Dinitrochlorobenzene..... lb.	30 — 32
Dinitronaphthalene..... lb.	25 — 30
Dinitrophenol..... lb.	33 — 35
Dinitrotoluene..... lb.	40 — 45
Dip oil, 25%, tar acids, car lots, in drums..... gal.	27 — 30
Diphenylamine..... lb.	38 — 40
H-acid..... lb.	60 — 70
Meta-phenylenediamine..... lb.	1.30 — 1.50
Monochlorobenzene..... lb.	1.25 — 1.30
Monothylaniline..... lb.	14 — 16
Naphthalene crushed, in bbls. (250 lb.)..... lb.	1.75 — 2.00
Naphthalene, flake..... lb.	08 — 08½
Naphthalene, balls..... lb.	08 — 08½
Naphthalonic acid, crude..... lb.	09½ — 10½
Nitrobenzene..... lb.	09 — 10
Nitro-naphthalene..... lb.	12 — 15
Nitro-toluene..... lb.	30 — 35
Ortho-amidophenol..... lb.	18 — 25
Ortho-dichlorobenzene..... lb.	3.20 — 3.75
Ortho-nitro-phenol..... lb.	15 — 20
Ortho-nitro-toluene..... lb.	75 — 80
Ortho-toluidine..... lb.	25 — 30
Para-amidophenol, base..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.10 — 2.20

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.85 — .90
Para-nitrotoluene..... lb.	.90 — 1.05
Para-phenylenediamine..... lb.	1.90 — 2.00
Para-toluidine..... lb.	1.30 — 1.60
Phthalic anhydride..... lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.12 — .14
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.85 — 2.00
Resorcinol, pure..... lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.25 — .27
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .32
Sulphur naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 — .18
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.28 — .32
Toluene, in drums..... gal.	.30 — .35
Xyldines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.40 — .45
Carnauba, 1st ra..... lb.	.68 — .70
Carnauba, No. 2, North Country..... lb.	.30 — .32
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.19 — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 — .03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 — .03½
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 125 m.p..... lb.	.05 — .05½
Paraffine waxes, refined, 128-130 m.p..... lb.	.05 — .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.06½ — .06½
Paraffine waxes, refined, 135-137 m.p..... lb.	.07 — .07½
Stearic acid, single pressed..... lb.	.11 — .11½
Stearic acid, double pressed..... lb.	.11 — .11½
Stearic acid, triple pressed..... lb.	.12 — .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.36
Turpentine, crude, sp.gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$6.25 —
Rosin E-I..... 280 lb.	6.25 —
Rosin K-N..... 280 lb.	6.25 —
Rosin W. G. W. W..... 280 lb.	6.50 —
Wood rosin, bbl..... 280 lb.	6.75 —
Spirits of turpentine..... gal.	.59 —
Wood turpentine, steam dist..... gal.	.53 —
Wood turpentine, dest. dist..... gal.	.52 —
Pine tar pitch, bbl..... 200 lb.	7.00 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	14.50 —
Retort tar, bbl..... 500 lb.	15.00 — 14.75
Rosin oil, first run..... gal.	.45 —
Rosin oil, second run..... gal.	.48 —
Rosin oil, third run..... gal.	.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — \$0.18
Upriver coarse..... lb.	.13 — .14
Upriver cauchoo ball..... lb.	.14 — .14½
Plantation—First latex crepe..... lb.	.19 —
Ribbed smoked sheets..... lb.	.17 —
Brown crepe, thin, clean..... lb.	.18 —
Amber crepe No. 1..... lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08 — \$0.09
Castor oil, AA, in bbls..... lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.07 — .08
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 — .09½
Cocoonut oil, Cochinchina grade, in bbls..... lb.	.09 — .10
Corn oil, crude, in bbls..... lb.	.08 — .08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04 — .04½
Cottonseed oil, summer yellow..... lb.	.06½ — .06½
Cottonseed oil, winter yellow..... lb.	.07 — .07½
Linseed oil, raw, car lots (domestic)..... gal.	.65 — .66
Linseed oil, raw, tank cars (domestic)..... gal.	.58 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.67 —

Olive oil, commercial.....	gal.	\$2.00	—	\$2.50
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.06
Peanut oil, refined, in bbls.....	lb.	.11	—	.11½
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	1.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blane fixe, dry.....	lb.	.05	—	.05½
Blane fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	30.00	—	35.00
Graphite, Ceylon lump, first quality.....	lb.	.08	—	.09
Graphite, Ceylon chip.....	lb.	.07	—	.08
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ to 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.62	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.47	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....	.....
Magnesite brick, soaps and splits.....	net ton	120	.....	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	.....	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	.....	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	.....	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	.16
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90.00	—	95.00
Ferromanganese, 76-80% Mn, English.....	gross ton	90.00	—	95.00
Spiegelisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.50	—	.55
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	5.00	—	6.00
Coke, furnace, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	28 3/4 @ 28 5/8
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35
Monel metal ingots.....	38
Monel metal, sheet bars.....	40
Tin, 5-ton lots.....	27.00
Lead, New York, spot.....	4.00
Lead, E. St. Louis, spot.....	3 95 @ 4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4 75

OTHER METALS

Silver (commercial).....	oz.	\$0.56½
Cadmium.....	lb.	1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	275.00 @ 300.00
Palladium.....	oz.	65.00
Mercury.....	75 lb.	47.00

FINISHED METAL PRODUCTS

Warehouse Price Cents per Lb.

Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	18.75
High brass wire.....	17.50
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland	Chicago
	Current	One Month Ago	One Year Ago	One Year Ago		
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50	.....	.....
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50	.....	.....
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50	.....	.....
Lead, heavy.....	3.00 @ 3.50	7.25	4.00	4.00	.....	.....
Lead, tea.....	2.00 @ 2.12½	5.25	3.00	3.00	.....	.....
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00	.....	.....
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50	.....	.....
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00	.....	.....
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50	.....	.....

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.60	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.80	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.80	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.20	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	3.80	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

SELMA—G. W. Tidd and associates have plans under way for the erection of a new plant at Tuscaloosa, Ala., for the manufacture of cement brick and kindred products. The factory will be equipped for a daily production of about 25,000 bricks.

California

LOS ANGELES—The Co-operative Glass Co., Bank of Italy Bldg., has awarded a contract to the Pozzo Construction Co., 421 Macy St., for the erection of a new 1-story and basement plant at Daly and Richmond Sts., consisting of two buildings, 91 x 180 ft. and 40 x 75 ft., respectively. The plant will cost about \$48,000.

MERCED—The California Pottery Co. will construct a total of 32 kilns at its new local plant, now in course of construction, and it is planned to commence operations in certain departments of the plant during April. It will give employment to about 300 operatives.

Georgia

SAVANNAH—A portion of the plant of the Atlantic Turpentine & Pine Tar Co., Central Junction, near Savannah, was destroyed by fire, March 4, with loss estimated at \$75,000.

Illinois

CHICAGO—The American Vat Color Co., of Chicago, Ill., has leased a building at 3223 South Western Ave., for manufacturing purposes.

Indiana

HAMMOND—The Standard Oil Co. of Indiana has purchased a 160-acre tract of land located in the cities of Hammond and Whiting, Ind., to make space for contemplated additions to existing plant.

Iowa

NEVADA—The Mason City Brick & Tile Co., Mason City, Ia., is considering the erection of a new brick and tile manufacturing plant at Nevada, to cost about \$250,000 with machinery. B. C. Keller is head.

Louisiana

SHREVEPORT—The Great Southern Producing & Refining Co., Indianapolis, Ind., has plans under way for the erection of a new unit at its Shreveport oil refinery. J. F. A. Moore, 900 Euclid Ave., Cleveland, O., is engineer.

BRAITHEWAITE—The Braithewaite Paper Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at \$75,000.

BASTROP—The Bastrop Pulp & Paper Co. has plans under way for the construction of a new pulp and paper mill. The first unit of the plant, estimated to cost about \$75,000, will be devoted to pulp production, and at a later date will be followed by the proposed paper mill.

Maryland

BALTIMORE—Victor C. Blode, Caton and Carroll Sts., manufacturer of chemicals, is planning for the rebuilding of the section of his plant damaged by fire on March 3.

BALTIMORE—Fire, March 3, caused a considerable loss at the plant of the Martin Fertilizer Co., Clinton and Fourth Sts., with damage including the acid and condenser departments.

Massachusetts

SALEM—The John C. Dow Leather Co., recently incorporated with a capital of \$50,000, has acquired the local plant of the Berkovitch-Mishel Leather Co., and will specialize in the manufacture of sheep leathers from pickled sheepskins. The plant will be equipped for color production, including black. John C. Dow, 196 South St., Boston, heads the company.

STURBRIDGE—George Kanutzen and George Kanutzen, Jr., are planning for the operation of local graphite properties. It is proposed to develop an extensive capacity at a site previously operated, but closed down some months ago.

Michigan

KALAMAZOO—The Kalamazoo Vegetable Parchment Co. is planning to break ground early in May for the erection of its proposed new local paper mill, comprising a two-machine addition to its present plant, 80 x 900 ft., and estimated to cost about \$400,000 with machinery. Billingham & Cobb, Press Bldg., are architects and engineers. J. Kindler is president.

WELLS—The Delta Chemical Co. is reported to be planning for the rebuilding of its plant, destroyed by fire, March 8, with loss estimated at \$500,000, including machinery. R. B. Goetschus is president.

Minnesota

ST. PAUL—The James Roe Glass Co., 109-13 East Ninth St., is planning for the rebuilding of the portion of its plant destroyed by fire, Feb. 27, with loss of about \$25,000.

New Jersey

TRENTON—Walter L. Collins, 64 Grove St., Milford, Mass., has made application to the local Chamber of Commerce for a plant or plant site, for the establishment of a new tile-manufacturing plant. The works will be used for the production of ceramic tiling under a new process. A company is now being organized by Mr. Collins. Secretary Conover, Trenton Chamber of Commerce, is in charge of the proposition.

BAYONNE—The Union Sulphur Co., 17 Battery Pl., New York, has acquired a tract of property in the Bergen Point district with frontage on the Kill van Kull of about 400 ft., and extending on First St. to the foot of Avenues C and D. The site will be used for a new works at a later date. At the present time the company will construct a large service building.

CARNEY'S POINT—E. I. du Pont de Nemours & Co., Wilmington, Del., is planning for the construction of a new color-manufacturing plant in this section. It is said that the proposed factory will be one of the largest dry color plants in the world, ultimately giving employment to over 20,000 operatives. The company is also reported to be arranging for the erection of a new lithopone plant.

New York

MASPETH, L. I.—The Gleason Tiebout Glass Co., has filed plans for extensions and improvements in its plant on Flushing Ave., near Garrison St.

BROOKLYN—Fire, March 10, destroyed a portion of the Sone & Fleming Oil Works of the Standard Oil Co., Greenpoint and Kingsland Aves., with loss estimated at \$150,000. It will be rebuilt.

North Carolina

HENDERSON—The Vance Guano Works, a subsidiary of the American Agricultural Chemical Co., 2 Rector St., New York, is planning for the rebuilding of its local plant, with number of new extensions. The work, including equipment, is estimated to cost about \$500,000. A capacity of about 50,000 tons of fertilizer per annum will be developed.

GREENSBORO—The Guilford Mining Co., 335 Harrison Apartments, recently organized, is planning for the development of copper and other mineral properties in the vicinity of Guilford, N. C. Considerable machinery for operation will be installed at an early date. J. C. White and R. F. Tittsworth, Knoxville, Tenn., head the company.

ROSE HILL—The Rose Hill Brick & Tile Co. has plans under way for the erection of a new local plant for the manufacture of cement tiling and kindred products. G. B. D. Parker, Chingquapin, N. C., is president.

Ohio

NEWARK—The American Bottle Co. has plans under way for the erection of a new building at its plant, 1-story, 250 x 500 ft.

The DeVore Co., 908 Nicholas Bldg., Toledo, O., is architect.

PIQUA—The American Strawboard Co., manufacturer of corrugated fiber products, has preliminary plans under way for the erection of a new 1 story plant. Headquarters of the company are at Akron, O.

BARNESVILLE—The Kearns-Gorsuch Glass Co., a subsidiary of the Hazel-Atlas Glass Co., Wheeling, W. V., is reported to be planning for the rebuilding of its local plant, destroyed by fire, March 3, with loss estimated in excess of \$500,000, including machinery. The company manufactures fruit jars, etc.

CAMBRIDGE—The Flannagan Pottery Co. is taking bids for the erection of an addition to its kiln department to cost about \$20,000.

WOOSTER—The Stellar Refinery Co. has completed plans for the erection of a new oil-refining plant in the vicinity of Cincinnati. The works will include a power house and pumping plant, and are estimated to cost about \$300,000 with machinery. E. M. Quincy is vice-president.

Oklahoma

TULSA—The Wilcox Oil & Gas Co. has preliminary plans under way for the erection of a new oil refining plant, with daily capacity of close to 5,000 bbl. The company has acquired a site, totaling about 150 acres, for the refinery and will expend about \$1,500,000 on the project. A new pipe line will be built from Bristow, Okla., to a point near St. Louis, Mo. Homer F. Wilcox is president.

PONCA CITY—James Gramme and associates are planning for the construction of a new lime-manufacturing works. The company has extensive limestone deposits in this district, and will devote initial operations to raw material production. A crushing plant will be installed at an early date.

Pennsylvania

MARCUS HOOK—The Union Petroleum Co. has construction under way on a new lubricating-oil works addition, about 200 x 200 ft. It is planned to place a portion of the plant in service at an early date. The tankage department will consist of 42 tanks, each 25 ft. in diameter and 30 ft. high, with 9 agitators and accessory equipment.

NORRISTOWN—A portion of the plant of the Norris Magnesia & Asbestos Co. was damaged by an explosion on March 9. An official estimate of the loss has not been made. It is said that the plant will be rebuilt at an early date.

HARRISBURG—The Harrisburg Bag & Box Co., 1550 Vernon St., manufacturer of paper specialties, will soon commence the erection of two new plant units, 1- and 2-story, about 64 x 125 ft., estimated to cost approximately \$200,000 with machinery. R. R. Markley, Spooner Bldg., Harrisburg, is architect. Samuel E. Eby is head.

Tennessee

MEMPHIS—The Memphis Packing Co. is considering the erection of a new local soap-manufacturing plant. Details are being arranged. Joseph Newburger is president.

Texas

DENTON—The Crescent Refining Co. has completed plans for the erection of a new oil refinery on a local site, with initial capacity of about 75 bbl. per day. J. A. Minnis is president.

Washington

SEATTLE—The Fisher Flouring Mills Co., Harbor Island, is negotiating with the Public Dock Commissioners, Portland, Ore., for the use of property at the Upper Albina ferry land in connection with its proposed new mills in this section, estimated to cost about \$800,000 with machinery.

West Virginia

MORGANTOWN—H. J. Booth, Pittsburgh, has preliminary plans under way for the erection of a new glass manufacturing plant in the vicinity of Round Bottom, W. Va. A site for the factory has been secured.

HUNTINGTON—The Huntington Tumbler Co., manufacturer of glass tumblers, etc., is planning for the erection of a new plant for increased output, to consist of a 1-story factory 80 x 275 ft., with two extensions, 60 x 60 ft. and 30 x 55 ft. respectively. The new works are estimated to cost about \$135,000 with machinery. A. F. Dickey, First National Bank Bldg., Huntington, is architect.

Wisconsin

JANESVILLE—George T. Simmons, R.F.D. 8, has broken ground for the erec-

tion of a new 2-story plant at Edgerton, Wis., 60 x 155 ft., to be equipped for the manufacture and assembling of porcelain spark plugs. The factory is estimated to cost about \$100,000.

Alberta

EDMONTON—The Imperial Oil Co. and the Edmonton Gas & Power Co. are seeking power from the Alberta Government, now in session, to enable them to construct pipelines for the purpose of conveying oil and gas, respectively, through the province. The line of route is not specified.

Quebec

MONTREAL — The Brompton Pulp & Paper Co. is arranging for a bond issue of \$3,000,000, a portion of the proceeds to be used for extensions, betterments and operations.

Industrial Notes

E. I. DU PONT DE NEMOURS & Co., Wilmington, Del., makes the following announcement of changes in organization, effective Feb. 1, 1921: The miscellaneous manufacturing department will be discontinued; substituted therefor within the production department, two new departments are created to be known respectively as the dyestuffs department and the paint and chemicals manufacturing department. The dyestuffs department will be in charge of C. A. Meade, V. P., with W. F. Harrington as director. The dyestuffs sales division and the dye manufacturing division have been transferred without change of personnel to form the selling and manufacturing divisions of the new dyestuffs department. The paint and chemicals manufacturing department will also be in charge of C. A. Meade, V. P., with Hunter Grubb as director and E. C. Thompson as assistant director. R. W. Sample has been appointed manager of paint and varnish sales, Eastern division, with headquarters at 35th and Gray's Ferry Rd., Philadelphia, Pa. The sales of paints and varnishes will be consolidated under Mr. Sample at Philadelphia for all of the company's selling branches, with the exception of Boston, Chicago, New York and San Francisco. The railway, industrial and architectural representatives of the paint and varnish section will also report to Mr. Sample.

THE AMALGAMATED METALS Co., producer of brass and bronze castings, has become affiliated with the Casey-Hudson Co., manufacturer of screw machines and other machine products at Chicago. The new offices will be located in the Casey-Hudson Co., 361 East Ohio St., Chicago, Ill.

FREDERICK JOHNSTON severed his connection with Marden, Orth & Hastings in order to direct the chemical sales division of the Michigan Iron & Chemical Co., Consumers Bldg., Chicago, Ill.

THE AUSTIN MACHINERY Co., of Louisiana, has been organized under the laws of the State of Louisiana for distribution of the products of the Austin Machinery Corp. in Louisiana, Arkansas, Mississippi and Tennessee. The general offices of the company are located at 1020 Maison Blanche Bldg., New Orleans, La.

F. J. RYAN & Co., Philadelphia, Pa., specialists in electric heating problems in both the chemical and the metallurgical industry, announce the election of the following departmental executives: S. H. Ourbacker, director of engineering, F. A. Hall, director of sales, and T. B. Bechtel, director of construction. F. J. Ryan & Co. was organized by Mr. Ryan, who has been allied with the electric-furnace development since its commencement in this country. The original company was organized in 1913, but was inactive for a period of three years when he occupied the position of director and general manager of the Electric Furnace Construction Co., and later as directing manager of the American Metallurgical Corp., the active business of which was terminated last October when F. J. Ryan & Co. was incorporated. The remaining contracts of the American Metallurgical Corp. have been completed by the new organization and practically all of the executives of the old organization have become members of the new. From this time on the new organization will specialize exclusively in electrometallurgy and electrochemistry. Departments for the manufacture of low-temperature ovens have been added, and structural and machine divisions created through associations with Philadelphia shops. A New York office has been opened recently at 21 East 40th St. under the direction of E. C. Melby. Mr. Melby will have supervision over the New York district and export field. His previous experience for a number of years in the export trade, specializing with the Scandinavian countries, makes him especially adapted to this district.

THE SURFACE COMBUSTION Co., Inc., 366 Gerard Ave., Bronx, New York City, manufacturer of industrial furnaces, has acquired the entire rights and interests of the Ratiometer Corp., Rochester, N. Y. The latter company has during the last few years manufactured ratiometers in Rochester, N. Y. The Surface Combustion Co., Inc., has established a separate manufacturing and sales organization in its own plant in New York City, where it will continue this business under the name of the Ratiometer Corp. The ratiometer is a mechanical device, invented by Ivar Lundgaard, for the automatic proportioning of gaseous fuels and the air used for their combustion. The manufacturers claim this device can be readily installed on any two-pipe system, automatic temperature control being maintained entirely through the gas line. Other patent rights recently acquired by the Surface Combustion Co., Inc., are the Clark principle of intermittent firing for enameling furnaces and the Langenberg-Fetterly furnace for heat-treating armor-piercing shells.

W. E. PRINDLE, who was formerly president of the Buckeye Dryer Co., has started the manufacture of direct, indirect and steam-heated driers, as W. E. Prindle Co., Columbus, O.

THE AMERICAN GAS FURNACE Co. announces that its entire personnel will henceforth be concentrated in a main office in Elizabeth, N. J., in which city its two plants are located; also that it has discontinued selling operations through its former sole agent, E. P. Reichhelm & Co., Inc. The results of this action will be the more thorough co-operation of the various departments and will place more intimately at the disposal of its patrons the entire organization of The American Gas Furnace Co.

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis., announces the following changes in the personnel and district office territory of Milwaukee and New York: G. S. Crane, who has been manager of the Cleveland office, will become manager of controller sales at the main office in Milwaukee. L. B. Timmerman will be in charge of the Cleveland office, and will act in the capacity of assistant to A. G. Pierce, manager of the central district. The Cincinnati office will become a part of the central district, with R. I. Maujer as branch manager. E. N. Lightfoot will assume the title of manager of the heating department, with headquarters at the New York works, and will be in full charge of all matters relating to the sale of electric-heating devices.

New Companies

THE AMERICAN WOOD CHEMICAL Co., Chattanooga, Tenn., has been incorporated with a capital of \$800,000 to manufacture chemicals and byproducts. The incorporators are R. L. Frost and John S. Wrinkle, Chattanooga.

THE INDUSTRIAL POTASH CORP., capitalized at \$30,000,000, has been incorporated at Salt Lake City, Utah, to exploit the alunite deposits at Marysvale, Utah. The incorporators are Ross F. Beckstrom and Jacob H. Krause of Rockford, Ill., and Francis F. Hansen and Louis Grollman of Chicago.

THE BRAZILIAN RUBBER REFINING & MFG. Co., New York, N. Y., has been incorporated with a capital of \$400,000 to manufacture refined rubber and finished rubber products. The incorporators are J. T. Coggins, F. Chamie and J. E. Strowbridge, 812 Bergen St., Brooklyn.

THE WEST LEATHER BELTING Co., Room 1021, 39 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$35,000 to manufacture leather belting and kindred products. The incorporators are K. H. West, Frederic O. Mason and Edward R. Adams.

THE AMERICAN PINE PRODUCTS REFINING Co., Savannah, Ga., has been incorporated with a capital of \$250,000 to manufacture refined oils. The incorporators are H. F. Hogeborn, Savannah; B. A. Deal, Jr., Nashville, Ga.; and H. B. Elliott, Salisbury, Md.

THE TROEGER PRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are F. S. E. A. and J. F. R. Troeger, 648 East Thirty-fourth St., Brooklyn.

THE KORTE PRODUCTS Co., 2858 Fifth Ave., Chicago, Ill., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are Samuel L. Goldberg, Charles Weiss and Frank Korte.

THE EAST LONG BEACH OIL Co., INC., Long Beach, Cal., has been incorporated with a capital of \$1,000,000 to manufacture

petroleum products. The incorporators are W. LeRoy Thomas, C. A. Willis and J. F. Collins, all of Long Beach. Swaffield & Swaffield, 529 First National Bank Bldg., Long Beach, represent the company.

THE UNITED STATES PULP PRODUCTS CORP., Newark, N. Y., has been incorporated under Delaware laws with a capital of \$1,750,000 to manufacture pulp specialties. The incorporators are Lindsey Hooper, Ernest L. Fox and L. G. Rowe, Newark.

THE MCCANN-SHIELDS PAINT Co., Pittsburgh, Pa., has been incorporated with a capital of \$15,000 to manufacture paints, varnish, etc. J. E. Shields, 1820 Metropolitan St., is treasurer.

THE CRYSTAL OIL Co., Richmond, Va., has been incorporated with a capital of \$2,750,000 to manufacture refined oil products. Whiting C. Faulkner, Richmond, is president, and W. E. Bryan, Denver, Colo., secretary.

THE GUASTI FINCH CHEMICAL Co., Vernon, Cal., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are Secondo Guasti, L. S. Finch and J. I. Barlotti, all of Los Angeles, Cal.

THE PRINCE RE-ENFORCED RUBBER Co., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture mechanical rubber products. The incorporators are Howard P. Knox, J. D. Prince and Herbert B. Morse, 140 Oliver St.

WOHL, LETRAK & Co., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture glass products. The incorporators are R. Dolgin, G. G. Rosenberg and B. Rabinowitz, 261 Broadway.

THE ERWIN CHEMICAL PRODUCT Co., New York, N. Y., has been incorporated with a capital of \$30,000 to manufacture chemicals and affiliated specialties. The incorporators are W. W. Jordan, M. P. Matthis and L. B. Erwin, Forest Hills, N. Y.

THE SANITARY CHEMICAL SPECIALTIES Co., 268 North Wells St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture chemical products. The incorporators are John W. and Arthur C. Tretow, and Walter H. Shryock.

THE SYKEVILLE GLASS Co., Pittsburgh, Pa., has been incorporated with a capital of \$25,000 to manufacture glass products. Dusan Botic, 2612 Sarah St., is treasurer.

THE MIDLAND CHEMICAL Co., Indianapolis, Ind., has been incorporated with a capital of \$10,000 to manufacture chemicals and affiliated products. The incorporators are H. R. Doty, L. D. Millikan and B. E. Jones.

THE OCEAN VIEW OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are W. G. Cline, F. H. Ballinger, Thomas F. Fitzgerald and J. H. Old, Los Angeles. George W. Bush, 431 Van Nuys Bldg., is representative.

THE HEPALIN CHEMICAL Co., Boston, Mass., has filed notice of organization to manufacture chemical products. Harry Belin and David Berman, 32 McClean St., head the company.

THE EMPIRE PAPER PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$300,000 to manufacture paper goods. The incorporators are A. B. King, D. V. Sullivan and J. G. Miller, 261 Broadway.

THE MOULTON PRODUCING & REFINING CORP., Buffalo, N. Y., has been incorporated with a capital of \$300,000 to manufacture refined oil products. The incorporators are George Wroblewski and E. York Ames, Buffalo.

THE HERBETTA MFG. Co., Indianapolis, Ind., has been incorporated with a capital of \$85,000 to manufacture chemicals and affiliated products. The incorporators are R. L. Walker, E. E. Gates and J. C. Ralston, Indianapolis.

THE TWINING-LARGE LIME & CHEMICAL Co., Carpenterville, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals, hydrated lime and kindred products. The incorporators are Robert G. Griswold, Willis W. and Charles J. Smith, Carpenterville.

THE NATIONAL CORK PRODUCTS Co., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture cork specialties and affiliated products. The incorporators are Leonard S. Lerman, Morris Uram and James Deckert. N. M. Fruchtman, 156 Market St., is representative.

THE UNION RUBBER Co., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture rubber goods. The incorporators are Raymond D. Smith, Waltham, Mass.; Joseph W. Worthen, Winchester, Mass.; and M. E. Buchanan, Newton, Mass.

THE TUCK & RICHTER MFG. CO., Gloucester, Mass., has been incorporated with a capital of \$50,000 to manufacture ink products. The incorporators are Albert B. Tuck, Alfred O. Richter and L. D. Tuck, all of Gloucester.

THE WINCHESTER PAPER CO., White Plains, N. Y., has been incorporated with a capital of \$50,000 to manufacture paper goods. The incorporators are W. M. Gilbert, A. S. Diven and J. C. Brophy, White Plains.

THE HOME CHEMICAL MFG. & IMPORTING CO., New York, N. Y., has been incorporated with a capital of \$150,000 to manufacture chemicals and chemical byproducts. The incorporators are P. Richter, G. J. Bittel and B. Schmidt, 937 East Fifteenth St., Brooklyn.

THE POWER & CHEMICAL EQUIPMENT CO., Hoboken, N. J., has been incorporated with a capital of \$10,000 to manufacture chemical apparatus, brass goods, etc. The incorporators are Edward D. Grosso, F. T. Morgan and John J. Marnell, 77 River St.

THE NATIONAL RUBBER GOODS MFG. CORP., Akron, O., has been incorporated under Delaware laws with a capital of \$2,000,000 to manufacture rubber products. The incorporators are R. A. Stillwell, Akron; W. H. Hill and B. Williamson, Cleveland.

THE BEAUMONT MIDWAY OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture refined petroleum products. The incorporators are J. Drew Funk, L. K. Strobel and C. A. Weaver, Los Angeles. Alfred Barstow, 600 Kerkhoff Bldg., is representative.

THE ESSEX CHEMICAL CO., 71 Paris St., Newark, N. J., has filed notice of organization to manufacture chemicals, lacquers, etc. George N. Beck, 97 Van Cleft St., Jersey City, N. J., is representative.

THE L. R. REICH DRUG & CHEMICAL CO., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and affiliated products. The incorporators are L. M. Warshow, S. and L. R. Reich, 66 Rende St.

THE CALCIUM CARBONATE CO., LTD., has been formed with a capital of \$50,000 for the purpose of manufacturing whiting from a deposit of decomposed shell-lime in Kane Valley, near Merritt, B. C. The initial unit will have a capacity of 10 tons daily. Up to now practically all the whiting used in Canada has been imported from Great Britain.

New Publications

BOOKS

LESSONS IN MECHANICS. By William S. Franklin and Barry MacNutt. Pp. 221; 178 figs. Bethlehem, Pa.: Franklin and Charles, 1919 (reprinted 1920). Price, \$2.

LESSONS IN ELECTRICITY AND MAGNETISM. By William S. Franklin and Barry MacNutt. Pp. 254; 188 figs. Bethlehem, Pa.: Franklin and Charles, 1919 (reprinted 1920). Price \$2.25.

LESSONS IN HEAT. By William S. Franklin and Barry MacNutt. Pp. 147; 41 figs. Bethlehem, Pa.: Franklin and Charles, 1920. Price \$2.

While these three companion volumes in a new series of physics texts were designed primarily to meet the needs of students taking a two-year schedule in college physics, chemists who wish to review physics will find them very helpful.

Realizing that students in the courses referred to will not have had higher mathematics the methods of calculus are introduced in the first volume of the series, so that strictly mathematical proofs do not have to be sidestepped. It is felt that this training in applied mathematics will help the student not only in the study of physics but in his work in pure mathematics.

The arrangement of the text is in strict lesson order. Descriptive and explanatory matter has been reduced to a minimum and the development of every topic leads as directly as possible to illustrative numerical problems. Lists of books for reference and for additional study are given in each volume, so that any phase of the subject can be taken up in more detail. Information about the national organizations and societies relating to physical science and engineering is also included, so that the student may become interested in the activities of these bodies early in his career.

Chemists will find "Lessons on Heat" especially interesting as an introduction to the study of thermodynamics. It includes chapters on: Temperature and thermometry; expansion; heat as a form of energy; calorimetry; thermal properties of solids, liquids and gases; transfer of heat; the properties of gases; the second law of thermodynamics.

INTRODUCTION TO GENERAL CHEMISTRY. By H. Copaux, professor of mineral chemistry at the School of Industrial Physics and Chemistry of the City of Paris. Translated by Dr. Henry Leffmann. Pp. 195; 30 illustrations. Philadelphia: P. Blakiston's Son & Co., 1920.

Prof. Copaux has written in compact yet clear form an introduction to the principles of physical chemistry. The treatment throughout is thoroughly modern. Dr. Leffmann has contributed a short appendix on hydrogen-ion concentration.

CHEMICAL ANALYSIS OF STEEL-WORKS MATERIALS. By Fred Ifotson, F.I.C., of the department of metallurgy, Sheffield University. Pp. 296; 21 illustrations. London and New York: Longmans, Green & Co., 1920. Price \$7.50.

This is a revision of those sections of "The Analysis of Steel-Works Materials" by Brearley and Ifotson which treated of the analytical chemistry of the raw materials and finished products of ferrous metallurgy, including refractories, slags, fuels, boiler feed water and boiler scale.

TESTING OF MOTIVE-POWER ENGINES. Second edition. By R. Royds, head of motive-power engineering department, Dundee Technical College. Pp. 392; 193 illustrations. London and New York: Longmans, Green & Co., 1920. Price \$7.50.

Detailed information is given in regard to the testing of: Locomotives, motor cars, etc.; steam engines and steam turbines; boilers; condensers and air pumps; internal combustion engines; gas producers; refrigerating equipment; air compressors; fans and blowers; water turbines and pumps.

BENZOL—ITS RECOVERY, RECTIFICATION AND USES. By S. E. Whitehead, F.C.S. Pp. 209; 65 illustrations. London: Benn Bros., Ltd., 1920. New York: D. Van Nostrand Co., Price \$5.

Experience gained during the war in the extraction of benzol from coal gas has been made available by Mr. Whitehead in the hope that the process may be made commercially attractive and profitable even in peace times. Careful consideration is given to the processes, equipment, operation and control methods used in the extraction of benzol from gas, the debenzolizing plant and the rectification plant. The chief uses of benzol and its products are treated briefly.

RUBBER MANUFACTURE. By H. E. Simmons, professor of chemistry, Municipal University of Akron, Ohio. Pp. 149; 55 illustrations. New York: D. Van Nostrand Co., 1921. Price \$4.50.

This book gives a general view of the geographical, physical, chemical and mechanical factors which make up the modern rubber industry. Topics treated include: Sources of crude rubber; colloids in relation to rubber; methods of coagulating the latex; theory of the constitution of rubber; synthetic caoutchouc; chemical and physical testing of crude rubber; manufacture and use of inorganic fillers, organic accelerators and rubber substitutes; vulcanization theories; reclaiming rubber; preparation of crude rubber for manufacturing; principles of compounding; chemical analysis of manufactured rubber; physical testing of compound samples. A description of the rubber laboratory equipment at the Municipal University of Akron is given in an appendix.

PAMPHLETS

THE COPPER DEPOSITS OF THE SEVEN DEVILS AND ADJACENT DISTRICTS, by D. C. Livingston and F. B. Laney. Bull. 8 published by the Bureau of Mines and Geology of the State of Idaho at the University of Idaho, Moscow, Idaho.

REFRATORIES FOR ELECTRIC FURNACES has been published by the Electric Furnace Assn., Niagara Falls, N. Y. This book contains the papers and discussions at the Columbus meeting of the Electric Furnace Association, Oct. 6, 1920.

THE FEDERAL WATER-POWER ACT is the title of a 40-page pamphlet published by Black, McKenney & Stewart, engineers, Washington, D. C. It contains a brief history of water-power legislation, a topical synopsis of the federal water-power act and a copy of the act itself.

Capital Increases, Etc.

THE SIMPSON CLARK GLASS CO., 164 West Randolph St., Chicago, has filed notice of capital increases from \$75,000 to \$100,000.

THE ALLIED OIL CORP., 15 East Fortieth St., New York, N. Y., has filed notice of increase in capital from \$12,500,000 to \$16,000,000.

THE LOS ANGELES SOAP CO., Los Angeles, Cal., has filed notice of increase in capital from \$250,000 to \$1,000,000.

THE NATIONAL BRASS CO., Grand Rapids, Mich., has filed notice of increase in capital from \$225,000 to \$450,000.

THE AMERICAN AGRICULTURAL CHEMICAL CO., 2 Rector St., New York, N. Y., manufacturer of fertilizers, etc., has arranged for a bond issue to total \$30,000,000.

THE ALLIED CHEMICAL & DYE CORP., New York, has filed notice of reorganization, to operate with an active capital of \$113,043,675 and preferred stock \$97,326,400.

THE KOKOMO OIL CO., Kokomo, Ind., has filed notice of increase in capital from \$15,000 to \$275,000.

THE FEDERAL CEMENT TILE CO., 110 South Dearborn St., Chicago, Ill., has increased its capital from \$150,000 to \$600,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL PETROLEUM CONGRESS is meeting at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.